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Hypoplasia of the Uterus with Special Reference to Spasmodic Dysmenorrhoea

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DURING the discussion on primary, intrinsic, or spasmodic dysmenorrhoea, at the British Congress of Gynaecologists and Obstetricians, held in Edinburgh in 1923, Eden quoted Mathews Duncan's definition of the condition as "a disease of the nature of neurosis, in which the contractions of the uterus cause great pain." In spite of the many additions to our knowledge since that time, this definition still covers all that is known, with any certainty, about dysmenorrhoea and its causation. None disputes the important part played by the nervous make-up of the individual and, with few exceptions observers are agreed that the pain, which is rhythmical or has periodic exacerbations, coincides with uterine contractions. Indeed a definite association has been demonstrated by studies in which uterine activity has been recorded by means of intra-uterine bags (Lackner and others,[1] Moir[2]). The character of spontaneous contractions, and the response of the uterus to oxytocic substances, varies according to the phase of the menstrual cycle. Knaus'[3] original suggestion that the greatest activity is shown about the time of ovulation and that the myometrium is refractory during the luteal phase, has not been confirmed, and the clinical experiments of Moir,[2, 4] Wilson and Kurzrok,[5] and Bickers[6] go to show that the quiescent uterus of the post-menstrual phase gradually becomes more active throughout both follicular and luteal phases, reaching a peak just before and during menstruation. They found that during the follicular phase the contractions are frequent but of low amplitude, whereas in the luteal phase the amplitude is high and frequency low. According to Reynolds[7] the results of these workers are open to question because of possible errors arising from the experimental technique employed, and he, on theoretical grounds, supports the view of Knaus. Nevertheless nearly all are agreed that the most powerful contractions are seen just before and during menstruation; some regard these contractions as the result of a progesterone influence,

while others conclude that they follow the premenstrual degeneration of the corpus luteum and the removal of the influence of its hormone. The theory advanced by Novak and Reynolds,[8] and widely accepted for many years, that spasmodic dysmenorrhoea is the result of a relatively excessive oestrogen effect on the uterus, is losing favour. Clinical experience goes to show that the contractions associated with a predominantly oestrogenic influence such as occur at the mid-interval phase of the cycle, in anovular menstruation, in metropathia haemorrhagia and in the presence of granulosa cell tumours, do not give rise to pain. Dysmenorrhoea has been induced artificially in women with anovular cycles by the administration of progesterone (Sturgis and Albright[9]), and most of the evidence goes to show that a corpus luteum influence is essential if dysmenorrhoea is to occur. Yet it should be pointed out that it is not uncommon to meet patients who experience lower abdominal cramps—presumably of uterine origin—during treatment with oestrogens, and also we have not noticed any pain to occur during the treatment of metropathia haemorrhagia in young girls, with large doses of progesterone (70–140 mgm. in one week). Moreover, in women who suffer from spasmodic dysmenorrhoea, the passage of the uterine sound, or an increase in intra-uterine pressure such as results from the injection of lipiodol, at any time in the cycle, usually results in severe pain identical with their menstrual pain. Again Hoffman,[10] from studies of the endometria removed during the second half of the cycle from women subject to dysmenorrhoea, concludes that not all show a progesterone effect. Our findings in this respect (see later) go to substantiate the general view that menstruation characterized by pain is nearly always of the ovular type. But until the work of Moir and his adherents is confirmed and controlled to the satisfaction of the Knaus school, then it is impossible to say whether the corpus luteum plays a positive *rôle* in determining dysmenorrhoea or whether painful uterine contractions arise only when the progesterone influence is withdrawn.

But, as Reynolds[7] and Lackner and others[1] point out, uterine contractions *per se* do not account for dysmenorrhoea, and contractions of equal amplitude may be painful in one individual and painless in another. Nevertheless, in a person suffering from dysmenorrhoea, the intensity of the pain is to some extent proportional to the amplitude of the contraction wave. Attempts have been made to discover a difference in the type of uterine contractions present in women suffering from dysmenorrhoea, and Bickers[11] claims to have demonstrated that when pain is produced the contractions are superimposed on a state of increased tonus or spasm of the muscle. But he found that an increase in tone alone does not produce pain and that it is the combination of tetany with an added high amplitude contraction which is operative. Wilson and Kurzrok,[5] however, using a similar technique failed to demonstrate any difference in the tracings of uterine contractions taken during painless and painful menstruation. It has been postulated, therefore, that the difference does not lie in the behaviour of the uterus but in the interpretation, by the nervous system, of the sensation induced by uterine activity. This, however, cannot be the whole truth otherwise dysmenorrhoea would tend to persist throughout the whole of the active reproductive life of an individual, whereas it is well known that it is frequently cured by pregnancy and in any case tends to disappear spontaneously after the age of 30 to 35 years. There must be a difference in the character of painless and painful uterine contractions even though

this difference cannot be demonstrated by methods which only register the increase in intra-cavity pressure resulting from contractions. The uterus is capable of different patterns of motility; the painless non-expulsive contractions of pregnancy are different from the expulsive and painful contractions of labour. Again the severity of the pain experienced in labour is not proportional to the efficiency of the uterine contractions: sometimes the most distressing pain results when the contractions in labour are incoordinate and the dilatation of the cervix delayed, If during labour, contractions of the uterus, although possibly of equal severity from the point of view of increasing intra-uterine pressure, may nevertheless be different in pattern and in functional efficiency, then we may suppose that such differences may occur in the behaviour of the non-pregnant organ. This brings us to the view that spasmodic dysmenorrhoea is essentially the result of incoordinate muscular activity—a view which is by no means new and is sometimes expressed in terms of a fault in uterine polarity. It is a theory which has much to recommend it and, although there is no experimental evidence to show that the contractions in dysmenorrhoea are incoordinate, yet a disturbance of uterine polarity would fit in with all the known clinical facts concerning spasmodic dysmenorrhoea, whereas other concepts do not. Even the possible *rôle* played by the corpus luteum would fit in because it has been suggested that oestrogen tends to coordinate uterine contractions while progesterone has the opposite effect.

The next question is whether contraction or spasm of the muscle is the direct cause of pain or whether, as suggested by Moir,[2, 12] it is the ischaemia resulting from powerful muscle action which is responsible. This view, which is attractive, explains dysmenorrhoea on the same basis as the pain experienced in angina pectoris and intermittent claudication. Even so, it can be stated that, in general, ischaemia of a muscle does not of itself give rise to pain; there must be muscular activity at the same time (Lewis[13]). The possibility of a vascular change being ultimately responsible, in part or whole, for the pain is borne out by what is now known about the part played by vascular spasm in initiating the menstrual flow. And again it may explain observations to the effect that pain resulting from uterine contractions (dysmenorrhoea and "after pains") can be relieved with progesterone without the contractions themselves being affected.

To summarize: the pain in spasmodic dysmenorrhoea is intimately related to contraction of the uterine muscle. The difference between painful and painless contractions is one of type rather than strength. There may be increased muscle tone or tetany but there is much to be said for the theory which supposes incoordinate action or loss of uterine polarity as the basic difference. A corpus luteum effect on the muscle is probably essential to painful contraction but it is not yet known whether the effect is a positive one, or a withdrawal phenomenon. It is possible that muscle activity, and hormones as well, operate to some extent by inducing a state of ischaemia.

Leaving aside the mechanism by which the pain is produced, the underlying cause of spasmodic dysmenorrhoea is the subject for innumerable theories, many of which are contradictory. Theories are based on disorders of the central nervous system, the local nerve connexions, the endocrine control of the uterus, the uterine circulation, and the myometrium itself. These are reviewed by Davis,[14] Cannon,[15] Novak and Reynolds,[8] Fluhmann,[16] Pullen and Hamblen, [17] Lackner and others,[1] Katz and Parker,[18] Ehrenfest,[19] Witherspoon,[20] Ken-

nedy,[21] and do not require discussion here. Suffice it to say that prominent among the theories put forward is the one which supposes that the abnormal contractions of the myometrium (and it has still to be proved that they are abnormal) are fundamentally the result of an error in uterine development. It is true that occasionally a gross malformation such as bicornuate uterus is the cause of intense pain, but in the vast majority of cases a gross abnormality is not present and in these the uterus is said to be in a state of hypoplasia. Indeed Blair Bell[22] stated that even a bicornuate uterus rarely causes dysmenorrhoea unless it is hypoplastic as well. Estimates of the incidence of uterine hypoplasia in primary dysmenorrhoea vary from 20 to 100 per cent (Davis[14]) and, although the importance of hypoplasia as a cause of dysmenorrhoea has been questioned by a few writers such as Pullen and Hamblen,[17] Davis,[14] Novak and Reynolds,[8] Fluhmann,[16] Randall and Odell,[23] the view still enjoys a wide popularity. Four British text-books on gynaecology, picked at random,[24, 25, 26, 27] give uterine hypoplasia as one of the most, if not the most, important cause of spasmodic dysmenorrhoea. This hypoplasia theory is of long standing and has become almost traditional. It was emphasized by many speakers at the British Congress in 1923, and the discussion at that time reflects opinions which are still widely held to-day. At that meeting Gemmell[28] was one of the few to give uterine hypoplasia a relatively unimportant place in the causes of spasmodic dysmenorrhoea, and he rated its incidence at rather less than 10 per cent (34 out of 350 cases).

It is postulated that in spasmodic dysmenorrhoea the uterus may be definitely smaller than normal, although well proportioned, or on the other hand it may be of the infantile or pre-pubescent type, either in size or shape. When the uterus is apparently normal in size and shape then it is said that the hypoplasia is manifested by faulty structure of the myometrium, there being a relatively greater amount of connective tissue as compared with muscle tissue. According to Israel[29] and Pullen and Hamblen[17] it was Schultz,[30] in 1903, who first emphasized the significance of the relative amounts of muscle and connective tissue. Meaker[31] says the myometrium of the hypoplastic uterus, like the uterus in infancy, may contain as little as 50 per cent muscular tissue, as compared with 90 per cent in the fully developed adult uterus. This statement by Meaker, although uncorroborated, is widely quoted and indeed it is difficult to challenge since few hypoplastic uteri are removed for section. But it should be pointed out that these figures do not agree with those mentioned by Whitehouse[24] who says the proportion of fibrous tissue to muscle tissue in the myometrium is 3:2 in infancy, 2:3 in adult years and 3:2 after the climacteric.

It is well recognized that minor malformations of the uterus, such as acute anteflexion of the cervix (cochleate uterus), conical cervix, pin hole os, and congenital retroflexion, are frequently but not necessarily associated with dysmenorrhoea. These too are set down as manifestations of hypoplasia.

If hypoplasia of the muscle causes spasmodic dysmenorrhoea how does it operate? Opinions are many and varied and may be summarized as follows: (*a*) disproportionate amounts of connective tissue and muscle give rise to irregular or incoordinate contractions, (*b*) the nerves in the immature connective tissues are under-developed and more sensitive; (*c*) the uterine cavity is small and results in compression of the engorged endometrium; (*d*) the underdeveloped muscle is inelastic; (*e*) the excessive amounts of connective tissue deprive the myometrium of elasticity; (*f*)

an associated vascular development defect; (*g*) the weak muscle allows stagnation of the blood in the pelvic organs, and this in turn leads to pressure stimulation of the nerves with resulting powerful uterine contractions; (*h*) since the uterine muscle is feeble, greater effort is required to expel menstrual blood.

So far as can be ascertained all these explanations are entirely hypothetical and none has the support of either experimental or clinical observations. In themselves they are not convincing and detailed comment on them seems unnecessary.

The recognition of oestrogens as a means of promoting uterine development, and their ready access in recent years has led to their employment in the treatment of dysmenorrhoea and renewed interest in hypoplasia as a cause of this symptom. Oestrogen therapy for dysmenorrhoea was introduced by Kennedy in 1932, and since then there have been numerous reports on its use [20, 29, 32, 33, 34, 35, etc.] In 1937, Stacey and Shoemaker[35] went so far as to say "the giving of oestrogenic hormones to the patient whose uterus is undeveloped seems to be the only logical indication for the use of hormones in the treatment of dysmenorrhoea." This is an extreme view however, and it would seem fair to say that the attitude of the majority of writers and the practice of most clinicians has been to advise and employ oestrogen when the uterus is considered hypoplastic and progesterone to allay uterine contractions and activity when the uterus is fully developed. For reasons briefly mentioned above the value of progesterone must be open to question on theoretical grounds, but this communication is more concerned with uterine hypoplasia, and its treatment with oestrogens.

It has been our endeavour to collect information as to the importance of hypoplasia as a cause of spasmodic dysmenorrhoea, and we hope in discussion to demonstrate the need for a clearer and more rational approach to this aspect of the dysmenorrhoea problem.

In all cases of dysmenorrhoea, particularly spasmodic, it is generally admitted that a nervous factor, low threshold for pain, neurosis or hysteria, plays an important part. Indeed Haman[36] has recently reported experimental evidence of a lowered pain threshold in dysmenorrhoea subjects. The patient's attitude to menstruation, her environment, mode of living, general development and posture, the nature of her work and recreation, all have their place in its aetiology, and if they are omitted from consideration here it is not because we wish to minimize their importance but rather to avoid clouding the single issue with which we are concerned.

Development of the Uterus.

Before presenting the results of our enquiry a brief summary of the present day knowledge of the development of the uterus is relevant. This is based for the most part on the writings of Scammon[37, 38] and Reynolds.[7]

The development of the uterus in the foetus in its early weeks is governed by a mechanism similar to that of other tissues. It is determined primarily by genetic characters and brought about by inductors or organizers. It is later under the influence of the gonads and probably other endocrine glands such as the adrenal. Fusion of the Müllerian ducts is completed about the end of the 3rd month of intra-uterine life, and thereafter the uterus undergoes a steady growth, its length increasing in proportion to body length, and its weight in proportion to body weight. Up to the 28th week, its length increases at the average rate of rather less than 1 mm. per week. After the 28th week its increase in size is more rapid as a result of oestrogen pro-

duction by the placenta and at birth it measures 35 mm. (about half the adult size). Within 2 weeks after birth its length is reduced by one third (to 23 or 24 mm.) and its weight by one half. This reduction is due to the removal of the placental oestrogenic impulse, and it affects the body of the uterus chiefly, the muscle fibres being reduced in number and size and the vascularity being decreased.

During infancy and childhood very little, if any, uterine growth takes place, and in a 2 weeks old baby the uterus is approximately the same size as it is in an average 10 year old girl. About the age of 10, further development begins and proceeds apace so that by the time of the menarche, or even 1 to 2 years before the first menstrual period (Scammon[37]), it reaches adult size. In so doing it nearly doubles its length and increases in mass tenfold. This period of uterine growth coincides with other external evidences of puberty. It is directly related to the menarche, and the later the onset of menstruation, the later the onset of this phase of growth: it occurs therefore in different individuals at any time between 10 and 18 years. This prepubertal development is almost entirely the result of an oestrogen stimulus, probably arising from the ovaries. The fact that the uterus does not grow during childhood is not because it will not respond to a stimulus. Unlike the ovary, which is refractory to external stimuli during the early years of childhood and after the menopause (Engle[39]), both myometrial and endometrial components of the uterus react to oestrogen at any age. This has been demonstrated experimentally in animals, and can be seen clinically when oestrogen deprival haemorrhage occurs soon after birth, or in the case of precocious puberty due to hypothalamic lesions and granulosa cell tumours of the ovary. The uterus does not grow during infancy and childhood because the stimulus for growth (oestrogen) is lacking. The effect of oestrogen is to produce hypertrophy of muscle fibres rather than hyperplasia by mitosis. It does, however, increase the number of muscle cells by stimulating metaplasia of connective tissue cells. True hyperplasia, such as occurs in very early pregnancy, is brought about by progesterone (Reynolds[7]).

In the course of its prepubertal development, the uterus undergoes the well-known change in shape whereby the body becomes proportionately longer than the cervix—the reverse of the infantile state of affairs. Although by the menarche the uterus is fully developed in regard to size and shape, there is some evidence to suggest that it is not fully equipped for the function of childbearing. Thus in both animals and human beings it has been shown that, for some time after the ovarian cycle is fully established, sterility is the rule because the uterus is often incapable of the full response necessary for implantation and development of the ovum. This comes after an interval and it has been postulated that either the uterus does not acquire this capacity until it has been repeatedly subjected to many cycles of ovarian stimuli, or its inherent ability to respond to hormonic agents, although present in infancy, is not fully manifested until a few years after puberty (Reynolds[7]).

It should be noted that this description of uterine development differs somewhat from the one given by Lane Roberts and others,[40] who quote Halban's work of 1906 to show that the reactivity of the uterus to the ovary only appears towards the end of intrauterine life. Moreover, they say that in rodents prepubertal development occurs in spite of oöphorectomy.

This summary would not be complete without reference to the position of the uterus during development. Novak and Reynolds[8] say that in foetal and early post-

natal life the uterus is sometimes anteflexed but not invariably so. Munro Kerr and others[27] imply that the corpus uteri is somewhat anteflexed but that the whole organ is retroposed. It is not easy to find a definite statement with evidence on this point but the common view (Blair Bell,[41] Whitehouse,[24] Fairbairn,[64] Crossen[65]) is that at birth the uterus shows very little flexion or version, its axis being vertical with perhaps a slight inclination forwards. Our impressions gained during the routine postmortem examination of several hundred stillborn babies, confirm this although we have not any records of accurate observations. Anteflexion (and sometimes retroflexion) only occurs as development proceeds and is not present to any extent until the prepubertal growth phase, or even later. It is certainly present, although perhaps not always in full degree, by the time of the first menstrual period.

We have heard it stated that at the age of 5 or 6 years, the uterus is cochleate in shape and that, as development proceeds, the angulation of the cervix on the body normally becomes less acute. But we cannot trace any published statement to this effect, nor any evidence to substantiate it. It may have arisen from the view which explains acute anteflexion of the cervix in the adult by supposing a persistence of the infantile position of the cervix (i.e. its axis in line with the vagina) while the corpus attains its normal forward inclination (Crossen and Crossen[65]).

It has been the custom of clinicians in the past to describe underdeveloped uteri as being infantile, prepubescent, or pubescent. From what has been said above, it is clear that the infantile state persists from birth to the prepuberty age. Thereafter the uterus either remains infantile or assumes the adult state and there is little to support the above subdivisions. In theory, there is perhaps some place for a group in which the uterus is "pubescent" as distinct from "mature"—i.e. when it is fully developed anatomically but is still incapable of full reproductive function, but in practice it would be difficult, if not impossible, to recognize this class.

The conditions necessary for full uterine development are: (1) the uterus must be endowed with an ability to utilize, and to respond to, ovarian hormones, (2) these agents must be produced and be available in sufficient amounts, (3) an efficient circulation to assure an adequate supply of oestrogens to the uterus.

Hypoplasia may result if any of these factors are absent and it is not necessarily the result of defective ovarian function. It not infrequently results because the uterus is incapable of response by reason of some inherent fault. This explains why some patients with no other sign of endocrine disturbance have hypoplastic uteri, and why the administration of oestrogens sometimes has no effect on the size of the uterus or on symptoms such as amenorrhoea. Hypoplasia might also result from the presence of some factor having the power to destroy, or render inactive, the oestrogenic hormone. At present this is largely a hypothetical cause but it has been postulated that disease such as tuberculosis may act in this way (Mack[42]). It may be added that there is little to support the view, widely held for many years, and recently fostered by Meaker[31] that, after 20 years of age, the uterus loses its inherent growth capacity. Indeed it would appear that after birth, the uterus possesses little, if any, inherent or intrinsic growth capacity. It has merely the ability to respond by growth to extrinsic stimuli. If it is this responsiveness which is said to be lost, then we shall later put forward evidence to show that such is not the case.

DIAGNOSIS OF HYPOPLASIA.

For the purpose of this study, the records of two series of hospital in-patients have been analysed. These consist of (*a*) 829 cases of spasmodic dysmenorrhoea, (*b*) 86 cases of proved uterine hypoplasia. Very early in the investigations it became clear that it is extremely difficult to say when a uterus is hypoplastic and when it is not, and it is probably this fact, together with varied conceptions as the nature of hypoplasia, which accounts in large measure for the oft-repeated statements about the incidence of hypoplasia as a cause of dysmenorrhoea. Opinions are frequently based on the impression of a clinician carrying out bimanual examination, and this often *per rectum* in the unanaesthetized patient. All with experience will agree that an estimate of the size of the uterus gained by such an examination can be very misleading. We have not, therefore, accepted vague statements about the uterus feeling hypoplastic or small as being diagnostic of hypoplasia except when they have been supported by additional evidence.

Symptoms which are often accepted as an indication of hypoplasia are the late onset of the menarche and the occurrence of infrequent or scanty menstruation. Although we shall later raise doubts as to their significance, we have investigated our cases from the standpoint of such symptoms.

The best available method of determining hypoplasia is by mensuration of the uterus and on this we have relied to a large extent. But even this does not give any idea as to the thickness of the uterine wall. Nevertheless, as mentioned previously, the length of the uterus increases progressively with development, and tallies with an increasing weight of the organ, so in ordinary circumstances the length should form a good criterion as to the development of the uterus, as it also does for atrophy. Meaker[31, 43] and Meigs[44] have emphasized the importance of comparing the length of the corpus and the cervix and using the resultant "uterine index" as an indication of development. Such separate measurements are so rarely recorded in our series that we have been unable to make use of the uterine index as means of diagnosis. In any case the value of the uterine index can be disputed because it infers that whenever the cervical canal is unusually long, the uterus is hypoplastic irrespective of the size and development of the corpus. Moreover, our attempts to measure the uterine index in a smaller and separate series have impressed us with the difficulty of recording accurately the separate lengths of cervix and corpus. It is often impossible to detect the internal os with a sound and usually the margin of error in measuring the length of the cervical canal is at least $\frac{1}{4}$ inch—an amount which seriously affects the calculated uterine index.

When using the total length of the uterus as a guide to hypoplasia another difficulty is encountered, that is, to distinguish between hypoplasia and atrophy either of the uterus as a whole, or of the myometrium. In theory the difference lies in the relative length of the cervix and corpus, but at operation it can be difficult and indeed is not infrequently impossible to say whether a uterus has never developed fully or whether full development has been followed at a later date by retrogressive change. When possible we have endeavoured to exclude cases of atrophy but in view of this difficulty it is certain that many are included in the second section of this work. But this is not such a great disadvantage for there is not much difference essentially between the two: development depends on an oestrogen stimulus and atrophy results when such a stimulus is removed. In structure the uterus undergoing atrophy tends to return to its original

state, the relative amounts of fibrous and muscle tissue in the senile and infantile uteri being similar. This confusion between atrophy and hypoplasia is common in the literature but writers do not appear to have been conscious of it or at least do not make comment.

The finding of inactive endometrium might also be indicative of generalized uterine hypoplasia, although this of course supposes that the myometrium and endometrium behave in a similar way in every case. In the majority the development and activity of each probably do run parallel since both have a similar origin and both respond to the same hormonic stimuli. Not all will agree with this assumption, especially the protagonists of the hypoplasia theory of dysmenorrhoea who recognize that in patients with spasmodic dysmenorrhoea, endometrial development and function is usually normal. Meaker[31] supposes that less oestrogen is required to affect the endometrium than the myometrium but experimental evidence in support is lacking. Indeed Clauberg[45] says that when oestrogen is administered, a hypoplastic uterus first increases in size and that endometrial proliferation is a later effect. This suggests that the myometrium responds to oestrogen more readily than does the endometrium. Moreover it should be pointed out that in uteri the dimensions of which are small the endometrium is usually thin and inactive, and in those uteri subjected to a prolonged oestrogenic stimulus, as in metropathia haemorrhagica, both endometrium and myometrium undergo hypertrophy. So in arriving at a diagnosis of hypoplasia or atrophy in the second series of cases we have taken into consideration the histological appearance of the endometrium as compared with the time in the menstrual cycle. We also present the details of the endometrial picture in 111 of the cases of dysmenorrhoea.

Hysterectomy was not carried out on any of the patients in either group so it has not been possible to study the myometrium microscopically and to assess the relative amounts of fibrous and muscle tissue.

Cases of Spasmodic Dysmenorrhoea.

The case records of 829 patients complaining of dysmenorrhoea have been analysed. These cases are selected in so far that only those patients with a typical history of spasmodic pain are included, and all cases in which acquired lesions such as infection, endometriosis and fibroids were either present or suspected, are excluded. Cases of gross uterine malformation such as uterus bicornis are also excluded.

Marital Status and Parity.

Of the 829 patients, 432 were single and 383 married (status unknown in 14); 42 had been pregnant but 15 had had abortions only. One hundred and ninety-five women complained of sterility in addition to dysmenorrhoea: in many of these cases the sterility was the primary complaint, dysmenorrhoea being a secondary consideration.

Age of Puberty.

The history of a late menarche is frequently taken as a possible indication of uterine hypoplasia. It certainly indicates a late onset of cyclical ovarian activity or at least a delay in the ovary reaching its full activities and it is therefore not unreasonable to suppose that it is associated with delayed uterine development. But it does not necessarily mean that the uterus never attains full development—that depends on whether ovarian function, when it is established, is adequate—and in many cases it is, even when menstruation does not begin until the age of 18 to 20 years.

If the figures presented in Table I are compared with those given by Kennedy[46] who investigated the records of 10,219

women of hospital class in Edinburgh and found the average age of the menarche to be 15.037±0.011 with a standard deviation of 1.707, it will be seen that the age if anything is lower for this series of cases. There is nothing to indicate that the age of menarche in women suffering from spasmodic dysmenorrhoea is higher than the average. Consequently, and if a late onset of menstruation does imply uterine hypoplasia, there is no evidence that the incidence of hypoplasia in these women is greater than the average, but rather the reverse.

TABLE I.

Age at Onset of Menstruation.

Age at last birthday	9	10	11	12	13	14	15	16	17	18	19	20	21	Unknown
No. of cases	2	5	43	112	160	225	142	77	37	15	3	0	1	7

Menstrual Function.

It is often stated that oligomenorrhoea and hypomenorrhoea are symptoms of uterine hypoplasia (e.g. Shaw,[26] Hoffman[10]). There is some reason to doubt this, but accepting this popular conception at its face value, our cases were investigated to see if they presented a high incidence of these types of menstrual upset. The terms hypomenorrhoea and oligomenorrhoea are used by different writers to mean different conditions and, to avoid confusion, we prefer scanty menstruation and infrequent menstruation.

(1) *Scanty Menstruation.* In assessing the incidence of a scanty flow some arbitrary dividing line had to be adopted and we include here those patients whose cycle was more or less regular within the limits of 24 to 32 days, and in whom the loss lasted 2 days or less. Out of the total of 829, and according to this standard, only 28 had scanty menstruation. Of these, 8 gave a history of the menarche delayed beyond the 16th birthday but all except 2 began to menstruate before the age of 18. If scanty menstruation is to be regarded as evidence of hypoplasia of the uterus, then only about 3 per cent of these cases of dysmenorrhoea suffered from such hypoplasia.

(2) *Infrequent Menstruation.* The menstrual cycle reflects the ovarian cycle and if a long cycle means impaired ovarian function then it might also mean defective stimulation of the uterus by the ovary and consequent incomplete development. In our series there were only 18 patients whose menstrual cycle was always or usually longer than 32 days, and in several of these the cycles were very irregular. The intervals between menstrual periods varied from 5 weeks to 8 months. Of these 18 patients, 15 began to menstruate before they were 16 and all were menstruating before their 18th birthday. This suggests that infrequent menstruation, except perhaps when the intervals are 3 to 6 months or longer, is not significantly associated with a late menarche. Again, and if infrequent menstruation does signify uterine hypoplasia (secondary to ovarian hypofunction), then the incidence of hypoplasia in this series of women suffering from dysmenorrhoea is low.

Our findings, pointing to a low incidence of scanty and infrequent menstruation among women suffering from dysmenorrhoea, do not support the views of Shroeder[47] and Mazer and Israel.[33] The latter, speaking of primary dysmenorrhoea, say " a history of menstrual irregularities or late appearance of the menarche is

elicited in many instances of this morbidity, suggesting the possibility of a common origin." However, the majority of writers, among whom may be mentioned Taylor,[48] Davis[14] and Bickers,[6] comment that women suffering from dysmenorrhoea do not usually have abnormal menstrual losses, and this majority view is confirmed by our results. Furthermore it should be pointed out that those who support the hypoplasia theory of dysmenorrhoea have always emphasized that adult women with supposedly infantile uteri may, and indeed usually do, exhibit normal menstruation (Blair Bell,[22] Clauberg,[49] Moricard,[50] Meaker[31].) Blair Bell and Meaker stress, and rightly we think, that when these types of menstrual disturbance occur in the presence of uterine hypoplasia, they are evidence of an associated ovarian hypoplasia or at least hypofunction. Nevertheless if uterine development is to a large extent dependent on ovarian function, then it is surprising that dysmenorrhoea, if caused by uterine hypoplasia, is rarely associated with disturbance of the menstrual rhythm. This discrepancy can only be explained by assuming that in nearly all cases of dysmenorrhoea due to uterine hypoplasia the fault lies in the inherent failure of the myometrium to respond to the ovarian stimulus, and yet, at the same time, that the endometrium reacts normally. To postulate the occurrence of such a set of circumstances, not as a rarity, but as common, is an explanation of a clinical observation which does not appeal to reason. We prefer the alternative interpretation of the findings, namely, that spasmodic dysmenorrhoea is not often associated with uterine hypoplasia.

Measurement of the Uterus. All our cases were examined under anaesthesia and the uterus measured by sound. The exact measurement is recorded in only 274 cases; in the remainder the operation notes record that it was normal (i.e. 2½ inches or more). The details are set out in Table II.

TABLE II.

1 to 1½ inches	0 cases
1½ to 2 ,, ...	3 ,,
2 to 2½ ,, ...	12 ,,
2½ to 3 ,, ...	106 ,,
3 to 3½ ,, ...	108 ,,
3½ to 4 ,, ...	45 ,,
" Normal length " (2½ inches or more) ...	555 ,,

These figures show conclusively that the over-all length of the uterus in patients suffering from dysmenorrhoea is rarely less than normal. In the whole series there were only 15 cases in which there was definite proof of this. Indeed in a high proportion the uterus was longer than the usually accepted normal. In these cases the uterus was frequently cochleate in type (acute anteflexion of the cervix). Other observers have noted that the uterus in dysmenorrhoea is not often reduced in length (Blair Bell[22]), and they explain that the uteri are nevertheless hypoplastic because the length of the uterus is made up to a great extent by an unusually long cervix which compensates for the relatively small corpus. In our cases the relative lengths of cervix and corpus are recorded so rarely that we are unable to give statistics but we are of the opinion that when the cervix is abnormally long, then the total length of the uterus is increased, i.e. the body of the uterus remains normal in length and is fully developed.

Although there were only 15 cases in this series in which the uterus was proved to be less than normal in its total length, yet, in conformity with custom, the notes of 120 patients contained a comment that the uterus felt small or hypoplastic on bimanual examination, carried out either with or without general anaesthesia. The actual measurement of the uterus was subsequently recorded in these 120 cases and

in only 9 was the uterus less than 2½ inches in length. In many it was longer than normal (see Table III). These findings go to

TABLE III.

Measurements of those Uteri said to feel small on Bimanual Examination.

1 to 1½ inches	0
1½ to 2 ,, ...	2
2 to 2½ ,, ...	7
2½ to 3 ,, ...	28
3 to 3½ ,, ...	18
3½ to 4 ,, ...	4
Normal length (2½ inches and more)	61
Total	120

substantiate our previous statement that a general impression of size is frequently misleading and should not be accepted as indicating hypoplasia in the absence of other evidence.

Malformations and Malpositions of the Uterus.

Some type of minor developmental abnormality of the uterus was noted in a large percentage of cases, the details being as follows:

Acute anteflexion of the cervix (Cochleate uterus) ...	368 cases
Congenital retroflexion and retroversion	50 cases
Conical cervix: with or without pinhole os	39 cases

Dysmenorrhoea occurring in the presence of gross malformation such as bicornuate uterus, where the arrangement of the musculature is obviously disturbed, is not difficult to understand but, in regard to the conditions in the above list, the position is more difficult. However it is not unreasonable to suppose that, even in such minor types of maldevelopment, the muscle wave might be affected and the contractions of different parts of the uterus lack co-ordination.

(a) *Acute anteflexion of the Cervix (cochleate uterus).*

This condition, which is common, is widely stated to be a sign of uterine hypoplasia (e.g. Whitehouse,[24] Blair Bell,[41] Shaw,[26] Wharton,[51] Munro Kerr,[27] Meaker,[31] Mazer and Israel,[33]). It always takes a high place in the list of causes of dysmenorrhoea, although estimates of its frequency vary. Gemmell[28] put the figure at nearly 20 per cent: in our case it is approximately 44 per cent. The variation is probably explained by the fact that the diagnosis depends entirely on the opinion of individual clinicians. In the hospital from which these cases are taken acute anteflexion of the cervix is a "popular" diagnosis, whereas the diagnosis of conical cervix or pinhole os is rarely made. Although it is recognized that this deformity often exists without the women experiencing painful menstruation, yet it can hardly be disputed that it does appear to play a part. But why should it be regarded as a manifestation of uterine hypoplasia? The evidence in favour is that the cervix is long and narrow, and Blair Bell[41, 52] claimed to have demonstrated an excessive amount of fibrous tissue in the region of the internal os. But if the cervix is long and narrow the corpus is usually well developed and certainly within normal limits as regards size. So that the over-all length of the uterus is increased. The menarche in these cases is not delayed, the menstrual flow is full and regular. Although the axis of the cervix more or less coincides with that of the vagina, flexion of the corpus on the cervix, or vice versa, is not characteristic of the foetal or infantile uterus, and it is difficult to understand statements to the effect that both acute anteflexion and retroflexion are "residua of the childhood state" (Mazer and Israel[33]). The uterus, as pointed out previously, does not acquire its flexion until its development is far

advanced. Indeed acute anteflexion could be regarded with equal reason as a manifestation of over-development as of under-development. According to Schroeder[47] the extreme angulation of the cervix is due to "contracture" but Crossen and Crossen[65] believe it to be due to a persisting infantile position of the cervix, that is, a failure to develop anteversion, the corpus meanwhile taking up its adult position. Blair Bell[52] says the localization of fibrous tissue anteriorly at the level of internal os results in the posterior uterine wall growing more rapidly than the anterior, thus making the angle between corpus and cervix more acute. Even if this be so an excessive deposit of fibrous tissue in one special area cannot be taken to imply generalized hypoplasia, neither can a failure of the cervix to become directed backwards. We submit that such evidence as exists does not justify the assumption that a cochleate uterus is an under-developed one, but rather that it is a maldeveloped one. In this connexion we agree entirely with the opinion of Novak and Reynolds,[8] Davis,[14] and with Gemmell,[28] who, as long ago as 1923, questioned the popular view in this respect. Blair Bell[22, 52] points out that acute anteflexion of the cervix is seen in uteri both of normal size and of small size. He, in common with most observers, considers that both types of uteri are hypoplastic, hence the dysmenorrhoea. However, it would seem more logical to conclude that since the constant feature of both types of uterus is the shape rather than the size, it is the malformation rather than the degree of development which is the factor causing the dysmenorrhoea.

(b) *Congenital retroflexion and retroversion.*

These types of deformity are again developmental rather than congenital and probably do not appear until development is well advanced. According to Munro Kerr and others,[27] retroversion and retrodisplacement are common, whereas retroflexion is rare. But opinions—and again it can only be a matter of opinion—must vary, and in many cases the uterus appears to be cochleate in shape and the condition analogous to acute anteflexion of cervix. Again there is no reason to regard the malformation as a manifestation of hypoplasia. Although the cervix is long, the body of the uterus is well formed—and menstrual function is good. The cavity of the uterus is usually longer than normal.

Endometrial Patterns.

Not all the patients had curettage performed and full details of both histology of the endometrium and the time of biopsy in relation to menstrual cycle are available in only 111 cases (Table IV).

TABLE IV.

Time in menstrual cycle	Proliferative phase	Proliferative phase and hyperplasia	Pregravid phase	Atrophic endometrium	Total
4th to 13th day	25			?4	29
14th to 20th day	18	2	22		42
21st to 28th day		2(a)	34		36
Over 28 days	1*		3		4

* This patient had an 8-weekly cycle.

There were 4 patients whose endometria showed small and inactive glands and the pathological reports contained a reference to possible atrophy. In each case, however, it transpired that the curettings were taken

within 1–2 days of the cessation of menstruation and their appearance was not inconsistent with a diagnosis of an early proliferative phase. Curettings taken between the 14th and 20th days of the cycle are reported as proliferative or pregravid in about equal numbers. This is to be expected in view of the natural variation in the time of onset of progesterone effects and also because a doubtful early secretory reaction was not accepted. There were only 2 instances in which the histological picture did not conform to the phase expected according to the stated date of the last menstrual period. In these ((a)—Table IV) the endometrium showed hyperplasia and not any sign of secretory activity in the last week of the cycle—indicating an anovular cycle. Apart from these 2 cases our findings support the view that menstruation characterized by pain is of the ovular type. Bickers[6] in his enquiry into 17 cases of dysmenorrhoea found endometrial evidence of ovulation in every case. But Lackner and others[1] found one exception in their cases. However, in a large series of cases it is only to be expected there are exceptions to this rule because of the many possible factors contributing to dysmenorrhoea. But if the part played by the corpus luteum in the etiology of spasmodic pain is as important as other evidence goes to show, then it is surprising that Hoffman[10] found that only two thirds of his patients showed a secretory endometrium in the second half of the menstrual cycle.

To conclude, in this series of 829 cases of spasmodic dysmenorrhoea, definite evidence of uterine hypoplasia was found in 15 cases only; and in a further 12 there was some evidence according to examination findings and menstrual history although the length of the uterus was not recorded as less than normal. At most there were only 27 patients (3.38 per cent) with a hypoplastic uterus. Our findings are contrary to those of numerous writers who variously estimate the incidence of hypoplasia as 20 to 100 per cent. They conform more closely with the reports of Gemmell[28] and Davis[14] who found hypoplasia in only 10 per cent cases. Moreover it should be remembered that even when hypoplasia is found it is not necessarily the cause of the dysmenorrhoea and so Davis expresses doubt as to whether, in his 10 per cent cases, the hypoplasia had much etiological significance.

Other Considerations.

So far it has been demonstrated that according to the limited *data* available, hypoplasia of the uterus was an infequent finding in this large series and even in the few cases in which it occurred there is nothing to prove that the hypoplasia in itself was a causal factor of the dysmenorrhoea.

But it is extremely difficult to present irrefutable evidence and it will remain difficult so long as the diagnosis of hypoplasia remains more or less a matter of individual opinion. Apart from the negative evidence provided by this series there are further points which merit discussion.

(1) *Age of onset of dysmenorrhoea.*

Spasmodic dysmenorrhoea often does not commence until a few years after the menarche, or, if present in slight degree at puberty, only becomes intense at a later age. The age at which the patient seeks advice is a good guide to this feature and Davis[14] found that the average age of patients seeking treatment for dysmenorrhoea (congestive and spasmodic) was 22.3 years, that is, about 7 years after the average age for the menarche. In our series of spasmodic dysmenorrhoea cases the ages of the patients at the time of treatment is shown in Table V.

It will be seen that the ages of the majority of patients fall between 18 and 28, implying a considerable interval between the menarche and the development of pain of such severity as to demand hospital treatment. For further evidence of this we have analysed the case histories of 457 patients of our series; the remainder are excluded because the details of the time of onset of dysmenorrhoea are not stated. The findings can be summarized as follows:

Onset of pain one or more years after menarche	240 cases
Slight pain at menarche becoming severe one or more years later ...	34 cases
Pain dating from the menarche. (In some of these cases it is possible that the pain at puberty was only slight, becoming more severe later)	183 cases
Total	457 cases

It will be seen that approximately 60 per cent (274 out of 457) experienced at least one year of painless menstruation or only slight dysmenorrhoea before developing incapacitating pain. The figure is rather higher than those given by other observers; thus the estimates of Novak and Reynolds,[8] and Randall and Odell,[23] are 42 per cent and 35 per cent respectively. But the age at which dysmenorrhoea asserts itself is difficult to compute and, no matter what the exact percentage may be, all writers are agreed that an interval between onset of menstruation and the onset of dysmenorrhoea, is common, and it is usually 2 to 4 years in duration. This time-lag is of some importance from the standpoint of this thesis. It has been suggested by Moir,[12] Sturgis and Albright[9] and others, that the reason for it is that, in the early years, menstruation is anovular, and it is only when the ovaries function fully and ovulate late that dysmenorrhoea shows itself. This view is supported by the fact, previously mentioned, that the presence of a corpus luteum would appear to be essential for dysmenorrhoea. Nevertheless, it is unlikely that anovular menstruation is constant even though it be common in young girls, and in that case one would expect them to have intermittent dysmenorrhoea, gradually becoming a constant feature as ovulation becomes more regular. Such is not the rule although there are exceptions. Moir's theory may be correct but another possible explanation comes to mind and follows what has already been said about the development of the uterus. The interval between the menarche and the onset of dysmenorrhoea coincides with the interval between full anatomical development of the uterus and the time when it is "matured" and capable of full reproductive function. If there is any significance in this coincidence then it would seem that dysmenorrhoea is evidence of complete rather than incomplete development. This is all the more logical if it be remembered that, in subjects of dysmenorrhoea, the severity of the pain is to some extent related to the strength of the uterine contractions. A well-developed muscle is likely to contract more forcibly than a hypoplastic one.

TABLE V.

Age	Below 15 years	15	16	17	18	19	20	21	22	23	24	25	26	27	28
No. of cases	2	—	18	31	57	51	54	55	58	58	49	43	47	48	49

Age	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	?
No. of cases	36	37	22	31	24	15	15	8	7	8	3	1	—	—	1	1

Another feature of the age of patients suffering from dysmenorrhoea is the fact, noted by all observers, that the pain tends to improve after the age of 30, and spasmodic dysmenorrhoea is rare after the age of 35. As mentioned previously, underdevelopment of the uterus is closely allied to atrophy, since both are dependent on the same cause—lack of the oestrogen stimulus. Atrophy is undoubtedly associated with a loss of muscle tissue and an increased proportion of fibrous tissue. If, therefore, one of the characteristics of hypoplasia is an excessive amount of fibrous tissue and it is this which causes painful contractions, why does not dysmenorrhoea commence as atrophic changes set in with advancing years?* In fact a woman approaching the menopause rarely, if ever, suffers spasmodic dysmenorrhoea.

(2) *Fibrous Tissue in the Uterine Wall.*

The occurrence of a high proportion of fibrous tissue in the uterine wall should have the effect of weakening uterine contractions and, contrary to the usual statement, reason would suggest that pain would be less likely to result. In any case there is no evidence to show that fibrous tissue does cause dysmenorrhoea and we have failed to find in the literature any convincing account of the microscopic demonstration of an undue amount of fibrous tissue in uteri which have been the seat of menstrual pain. Observations, for the most part, have been made on isolated specimens only. Schultz,[30] who is reputed to be the originator of the theory, did not support it with histological *data*. However, in 1912 Schickele and Keller,[53] who studied sections of the myometrium in a series of cases, concluded that there was no relation between the amount of fibrous tissue present and the occurrence of dysmenorrhoea. It would appear, however, that these writers were more concerned with so-called "chronic metritis" and congestive dysmenorrhoea. Again there appears to be considerable difference of opinion as to what is to be regarded as the normal proportion of connective tissue in the myometrium at various ages.

The adherents of the fibrous tissue theory of dysmenorrhoea follow Schultz[30] in explaining the cure of the pain by pregnancy by assuming that pregnancy improves the development of muscle at the expense of fibrous tissue. However, according to Reynolds[7] the most constant and permanent effect of pregnancy is an increase in the connective tissue elements in the myometrium. This is true to some extent during pregnancy and is obvious after pregnancy when a de-differentiation of muscle fibres takes place.

Nevertheless, it may still be argued that a patch of fibrous tissue, localized to some site such as the internal os, such as Blair Bell[52] claims to have demonstrated in the cochleate uterus, might interfere with the contraction wave or in some way disturb the polarity of the uterus. Davis[14] does not accept this because the painful contractions are essentially rhythmical without evidence of incoordination. This argument is not necessarily valid, however, because contractions may still occur at regular intervals even though the muscle wave is not co-ordinated from the standpoint of function. However, it should be pointed out that the presence of scars in the uterine wall, as after Caesarean section or myomectomy, although a theoretical cause of dysmenorrhoea, rarely have such an effect. And this is true even when the scar extends transversely at the level of the internal os, or isthmus, as after the lower segment operation.

* Unlike most writers, Crossen and Crossen[65] consider that atrophy of the uterus in virgins over the age of 30 does sometimes cause dysmenorrhoea.

(3) *Size of the Uterus.*

Apart from the evidence given previously, it should be mentioned that several observers have commented that the uterus of patients suffering from dysmenorrhoea subjected to laparotomy never looks small or infantile in form. Conversely, many women with proved hypoplastic uteri do not experience dysmenorrhoea, and this is admitted by those who support the hypoplasia theory of dysmenorrhoea. Taylor,[48] in her recent clinical survey of 200 girls, came to the conclusion that a small uterus was found more commonly in the mild than in the severe grades of dysmenorrhoea. Mazer and Israel[33] make the interesting comment that uterine (and ovarian) hypoplasia associated with thyroid or pituitary hypofunction rarely causes dysmenorrhoea because patients suffering from such disorders are necessarily of phlegmatic disposition, insensitive to pain.

Cases of Uterine Hypoplasia.

The second part of our investigation consisted in a study of the case records of 86 consecutive patients whose uteri were proved to be undersized by a cavity measurement of less than 2½ inches. The difficulty in distinguishing hypoplasia from atrophy has already been mentioned and it should be emphasized that the finding of a small uterus does not necessarily mean that it has not once been fully developed and that it has not subsequently diminished in size and become inactive. In order to exclude as far as possible all cases of natural menopause, and of delayed puberty within physiological limits, only patients within the age limits of 18 and 40 are included. A further difficulty at once manifests itself—a large proportion of patients with proved hypoplasia or atrophy suffer from amenorrhoea and are therefore valueless from the point of view of a study of dysmenorrhoea.

Hypoplasia and atrophy result either from lack of oestrogen or an inability of the uterus to respond to an oestrogenic stimulus. It might be supposed that once a uterus has been capable of response to oestrogens, it always remains so, and the atrophy therefore is always due to ovarian failure. Although this is ordinarily true, thus the post-menopausal uterus will nearly always respond, it is not always true and we know of a few cases of secondary amenorrhoea and uterine atrophy in which enlargement of the uterus and further uterine haemorrhage could not be produced by the exhibition of oestrogens. This is sometimes seen in the presence of general disease such as tuberculosis, and it may be that such clinical observations are accounted for by some circumstances inactivating or destroying the oestrogen (*vide supra*), rather than by loss of uterine reactivity. Prolonged oestrogen therapy might of course make the uterus refractory, at any rate for a time, but Mazer and Israel[33] say that the uterus may become insensitive after a long period of amenorrhoea. It seems unlikely, however, that uterine inactivity alone could have this effect and the suggestion is not borne out by cases which we quote later.

It is doubtful whether it is permissible to assume that the endometrial response by haemorrhage, and the myometrial response, of a uterus, follow a similar pattern, although most of the available evidence shows that they do, at least in the majority of cases. In our enquiry into cases of hypoplasia we have therefore assumed that such is the case and a uterus which cannot be made to bleed with oestrogens is presumed to be insensitive to these principles in other respects as well.

We have attempted to assess the primary cause of uterine hypoplasia or atrophy in these 86 cases and our conclusions are shown in Table VI. In the section "uterus unresponsive" are included those cases in

TABLE VI.

Causes of Uterine Hypoplasia (or atrophy) in 86 Cases.

		Cases
A. *Uterus Unresponsive to Oestrogen* ...		21
B. *Endocrine Dysfunction.*		
1. Primary pituitary fault		
(*a*) Fröhlich's syndrome	8	
(*b*) Simmond's syndrome	5	
(*c*) Cushing's syndrome	2	
(*d*) Infantilism	4	23
(*e*) Gigantism	2	
(*f*) Partial pituitary failure following pregnancy	2	
2. Primary ovarian fault.		
(*a*) Premature menopause	3	5
(b) Eunuchoid syndrome ...	2	
3. Primary thyroid dysfunction ...		1
4. Primary adrenal cortical dysfunction		2
5. Endocrine disturbance ? Primary in ovary ? Primary in pituitary ...		12
C. *Endocrine Dysfunction or Unresponsive Uterus or Both*		12
D. *General Disease.* T.B., anaemia, etc.		4
E. *Anorexia Nervosa or Hysteria* ...		3
F. *Environmental Factors*		3
Total		86

which uterine response, as judged by withdrawal haemorrhage, could not be produced by oestrogens. In general, it can be stated that the smaller the uterus, the less likely it is to respond. Other clinical features are summarized in Tables VII, VIII, IX and X.

Our main concern has been to determine how many of these patients with small uteri suffered from spasmodic dysmenorrhoea. Sixteen patients had primary amenorrhoea and can therefore be omitted from consideration; 42 patients had secondary amenorrhoea and of these 3 gave a history of having had spasmodic dysmenorrhoea in the past. This finding however is of little significance since at the time they were menstruating the uterus may have been normal in size, atrophy and amenorrhoea having set in later. Twenty-eight patients were menstruating at varying frequencies and of these only one complained of severe dysmenorrhoea; 4 others mentioned dysmenorrhoea as a subsidiary complaint, while another 3 admitted having minor discomfort with menstruation, but of this they did not complain.

TABLE VII.

Age of Patients

Age	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
No.	9	10	10	5	4	1	5	1	2	5	6	6	6	0	5	1	3	1	0	4	1	1	0

TABLE VIII.

Age at Onset of Menstruation.

Age	Unknown	10	11	12	13	14	15	16	17	18	19	20	Never menstruated
No.	2	2	3	2	10	18	15	8	5	3	1	1	16

TABLE IX.

Length of the Cavity of the Uterus.

Uterus rudimentary and not canalized ...	4	cases
Less than 1 inch	1	,,
1 to 1½ inches	3	,,
1½ to 2 inches	7	,,
2 to 2½ inches	36	,,
Less than 2½ inches, but exact measurement not recorded	35	,,

Judging by the statistics given by Pullen and Hamblen,[17] Hoffman,[10] Mazer and Israel,[33] Randall and Odell,[23] Miller,[54] Ehrenfest,[19] Davis,[14] Winther[55] 35–50 per cent of all women experience some menstrual discomfort, and 5–10 per cent experience incapacitating pain. So the incidence of dysmenorrhoea in this series is not above the average, and it could with

some justification be claimed that it is less than average. There is nothing to suggest, therefore, that hypoplasia in itself causes dysmenorrhoea.

Study of the age of the menarche and the subsequent menstrual rhythm in these cases raises some doubts about the validity of other traditional opinions about uterine hypoplasia. The high incidence of amenorrhoea conforms to the accepted view. If those patients with primary amenorrhoea are excluded, it can be seen from Table VIII that the age of the onset of menstruation quite often falls within the normal limits. Fifty out of 68 patients began to menstruate before their 16th, and all except 5 before their 18th birthday. A late menarche is not so constant a feature of uterine hypoplasia as many would have us believe. Among those patients who were menstruating, only 3 had scanty menstruation and this goes to show that the amount and duration of the flow bears no close relation to the development of the uterus and, incidently, to the efficiency of the ovaries. Infrequent menstruation is common, however, and this is not surprising since the cycle reflects ovarian function and deficiency of the latter would account for uterine hypoplasia or atrophy.

It can be concluded that the menstrual disturbances which should lead the clinician to suspect uterine hypoplasia are amenorrhoea or infrequent menstruation; a late menarche may or may not be significant. In the case of amenorrhoea the fault may lie primarily in the uterus, or the ovary, but in infrequent menstruation, the fault is always in the ovary, and the smallness of the uterus is merely a secondary effect, as is the symptom of infrequent menstruation.

The Use of Oestrogens in the Treatment of Uterine Hypoplasia.

So far we contend that this investigation provides little evidence to substantiate the view that uterine hypoplasia causes spasmodic dysmenorrhoea, or at least that it is concerned in only a small percentage of cases. But for reasons already mentioned it is difficult if not impossible to prove it conclusively. Oestrogens are certainly responsible for the normal development of the uterus and for maintaining its integrity, and if spasmodic dysmenorrhoea is due to underdevelopment then oestrogen therapy, so frequently advised, is at first sight not unreasonable, in spite of the fact that a deficiency of oestrogen in the blood —or indeed any upset in the hormone level in the blood—has not been demonstrated (Fluhmann,[16] Katz and Parker[18]).

Clauberg[49] claims to have demonstrated radiologically an increase in size of the uterus following oestrogen administration, and the experience of most clinicians is that a small uterus can often, but not always, be stimulated to full development, but the effect is usually a temporary one (Mazer and Israel[33]). Nevertheless, Lardaro,[56] using stilboestrol in the treatment of 30 cases of infantile uterus, found that the size and consistence of the uterus were altered in 5 only. In 3 of these the effect produced was temporary and Lardaro

TABLE X.

Menstrual Function.

Primary amenorrhoea	16 cases	Epimenorrhoea	2 cases
Secondary amenorrhoea	42 ,,	Normal	7 ,,
Menstruating	28 ,,	Infrequent menses	16 ,,
		Scanty menses	3 ,,

concludes "except in rare instances, the drug does not produce any demonstrable enlargement of the uterine cavity." Kaufmann (quoted by Ehrenfest[19]) also found that, in cases of uterine hypoplasia associated with primary amenorrhoea, the uterus rarely responded to oestradiol benzoate. The effect of oestrogen therapy depends on the inherent ability of the uterus to react in any given case: if the uterus is sensitive and its hypoplasia caused by oestrogen deficiency, then the administration of oestrogen results in its full development. This effect is temporary, however, and the uterus quickly returns to its former state when treatment is suspended. Moreover, oestrogens inhibit the function of the ovaries so these may eventually be less able to maintain the uterus in its fully developed state. Again this type of replacement therapy cannot be continued successfully for an indefinite period, for after a time it ceases to have any stimulating effect on the uterus and atrophy sets in. It may be argued and indeed has already been suggested by Lane Roberts and others[40] that, when uterine hypoplasia is considerable in degree, then the giving of oestrogen may be necessary to assist the ovaries in producing full development which, once attained, can be supported by the ovaries even when their function may be somewhat subnormal. This view presupposes that more oestrogen is required to develop the uterus than to maintain its integrity and function and yet there is no evidence that this is so. In fact uterine development normally proceeds apace at a time when the ovaries have not yet assumed their full activity. It would seem more reasonable to postulate, as do Allen and others[57] in respect of the endometrium, that a higher output of oestrogen is required to maintain the uterus in a state of full development than to stimulate its development over a period of time. In regard to this aspect of the subject we should like to quote a recent experience with a patient (included in our second series) who suffered from an androgenic adenoma of the adrenal cortex and at the age of 30 presented the classical features of the adrenogenital syndrome, features which had gradually developed since the age of 14. She had never menstruated and at laparotomy the uterus was found to be about the size and shape of the uterus in infancy. It was so small and thin that it could not be palpated on bimanual examination under general anaesthesia. The ovaries contained numerous atretic follicles, ovulation and ovarian activity having been suppressed by a very high androgen output by the tumour. After the tumour had been removed it was at first thought—in line with current opinion—that the administration of oestrogens would probably be necessary in order to bring the uterus to full development, before it could be expected that the ovaries themselves could commence a regular menstrual cycle. Nevertheless, such treatment was deliberately withheld and, within 8 weeks, the uterus increased to normal size and the patient began to menstruate and thereafter had a regular cycle. The cure of primary amenorrhoea at the age of 30 is a striking feature of this case, but what is even more remarkable is the demonstration of the ability of the ovary, when allowed to function normally, to promote full uterine development, even at a late age. And yet how often has it been stated that it is difficult, if not impossible, to cure uterine hypoplasia once the patient has reached the age of 20. Meaker[31] says that after 20 years the growth impulse is lost and he supposes that the cause of hypoplastic uteri seen in women with a normal menstrual cycle is a transient glandular derangement in youth. This idea, which receives constant support, and often leads to the premature treatment of what is only a slightly delayed

but otherwise normal puberty, has no foundation if the concept of uterine development as set out here is true. Our interpretation of the facts known at present is that if the ovary is capable of ovulating and of stimulating the uterus to menstruate, then it is capable of promoting full development of the uterus. And this is true at any age providing the uterus is sensitive, and providing that there is no factor resulting in oestrogen destruction. Any endocrine derangement resulting in temporary hypofunction of the ovary does not permanently impair the ability of the uterus to develop and if, at a later date, ovarian function is sufficiently restored to produce menstruation, then the uterus will also attain adult proportions.

One further feature of the case quoted above deserves mention. During her first few menstrual periods the patient did not experience any pain, but after 3 or 4 months, the patient began to complain of moderately severe spasmodic dysmenorrhoea. In other words the onset of dysmenorrhoea coincided with full development and not the reverse; or it may be, if Moir's theory is correct, that the initial bleedings were anovular and only when the ovarian cycle was fully established, with corpus luteum formation, did the patient experience pain.

Another interesting case is quoted by Pratt.[58] A girl of 17, having previously menstruated regularly, adopted a strictly limited diet to reduce her weight and, as a result, developed secondary amenorrhoea and uterine hypoplasia (more strictly atrophy) which lasted 10 years. After marriage and a return to normal diet, the condition corrected itself, menstruation became regular, the uterus normal in size, and a pregnancy ensued. And there must be many cases of this type, showing that suppression of ovarian function for many years does not interfere with the uterus assuming or resuming its normal proportions and functions, once the ovarian cycle is established or re-established.

But what of those patients whose ovarian function is adequate and in whom hypoplasia is the result of uterine insensitivity to hormones? In such cases oestrogen therapy is only rational if it can be shown that the insensitivity of the uterus can be overcome by increasing the level of hormone in the blood above the normal. Our comments on postpubertal development include reference to the possibility that full functional capacity may be dependent on exposure of the uterus to stimuli from repeated ovarian cycles, but so far as we are aware there is no definite experimental proof that an oestrogen influence does make the uterus more sensitive to this hormone; opinions vary. Mazer and Israel,[33] dealing with amenorrhoea, say that in those cases in which the uterus initially will not respond by oestrogen withdrawal haemorrhage, treatment should be continued for a period in the hope of increasing its sensitivity, but they point out that failure is common. The same authors, referring to pituitary disease, say "oestrogen is valuable in combating the uterine atrophy and in increasing the responsiveness of the uterus to improved ovarian activity obtained through other measures."

Clauberg[49] maintains that both the animal and human uterus, after being subjected to the influence of oestrogen, responds better to that hormone than does the infantile one. However, Moricard[50] says quite definitely that the administration of oestrogen to patients whose own oestrogen production is normal, does not have any good effect on a hypoplastic uterus. Lane Roberts and others[40] suggest that oestrogen therapy does influence uterine hypoplasia, even in those patients with normal hormone levels, but they conclude that in such cases the ovaries are under-

active rather than inactive. They do not claim that uterine sensitivity is increased, and indeed point out that the reactivity of the uterus develops in spite of the absence of ovarian activity. The only proved effect of oestrogen on uterine reactivity is the depression which follows prolonged administration. On the evidence so far available it is not permissible to conclude that the sensitivity of the uterus to oestradiol produced by the patient's ovaries, is increased by the administration of other oestrogens. If it were so, the uterine effects of oestrogen therapy which has been practised so widely in recent years, would have been more permanent.

If this conclusion is correct then uterine hypoplasia which exists in spite of normally functioning ovaries cannot be effectively treated with oestrogens and this applies no matter whether the patient's symptoms are amenorrhoea, dysmenorrhoea or sterility.

On the other hand, if the uterine hypoplasia is secondary to ovarian hypofunction, then the administration of oestrogens is equally valueless from the point of view of a cure; unless the ovarian fault is corrected sterility will persist in spite of a temporary increase in size of the uterus, and amenorrhoea will return as soon as treatment is suspended. This is not to deny the administration of oestrogen any place in the management of cases of uterine hypoplasia. But it should be employed as a diagnostic measure—to determine, by its intermittent application over a period of 1 to 3 months, whether the uterus is capable of response, and thus to assist in the diagnosis of the underlying cause of the hypoplasia or atrophy.

If uterine hypoplasia rarely if ever causes dysmenorrhoea, and if in any case oestrogenic hormone therapy is of no value in producing permanent, and in many cases even temporary, enlargement of the uterus, then how can we account for the reports[9, 33, 34, 35] of good results attending oestrogenic hormone therapy for spasmodic dysmenorrhoea. This has recently been discussed by Pullen and Hamblen[17] and there are many possible explanations.

1. Oestrogens may exert an effect on dysmenorrhoea by increasing the vascularity of the uterus, thus counteracting to some extent the ischaemia which is possibly an important factor in the causation of the pain. Also the contractions resulting from oestrogens as distinct from those due to progesterone tend to promote a better uterine circulation (Reynolds[59]).

2. Dysmenorrhoea does not occur except in the presence of progesterone. If oestrogens are administered in the first half of the cycle, ovulation and corpus luteum formation may be inhibited and the ensuing menstruation will be anovular and therefore painless. Sturgis and Albright[9] and Bickers[11] claim to have demonstrated by clinical experiment that when oestrogens relieve dysmenorrhoea, this is the mechanism involved. If oestrogens are given after ovulation they may still act by depressing corpus luteum activity. In assessing this view, it should be remembered that oestrogen has been shown to promote corpus luteum formation and to influence its function favourably (Hoffman,[10] Fevold,[60] Allen and others[57]).

3. It has been suggested that oestrogens may affect the central nervous system raising the threshold for pain.

4. Oestrogens may counteract the degenerative change in the paracervical nerve ganglia. Kennedy[21] first demonstrated these changes as a feature of dysmenorrhoea and claims to have shown that they can be counteracted by oestrogens.

5. By promoting growth, softening, and vascularity of the cervix, oestrogens may help to restore uterine polarity to normal, or again it has been suggested that oestro-

gen tends to co-ordinate uterine contractions, progesterone having an opposite effect.

6. One of the effects of oestrogens is the liberation of acetylcholine or some similar substance and this, by acting on parasympathetic nerve endings, may influence either vascularity or the neuromuscular mechanism (Reynolds[7, 61]).

It has still to be proved that oestrogen does have any specific effect on spasmodic dysmenorrhoea. Bishop[62] estimates that reports in general indicate relief of symptoms in 50 per cent cases, although the effect is temporary ([9, 33, 34, 35]). But it is not difficult to find claims for equally good results for all manner of treatments—progesterone, testosterone, gonadotrophin, general hygienic measures, psychotherapy, desensitization, various drugs and operative procedures. The nervous factor is so important in dysmenorrhoea that any treatment acting psychologically will yield a good percentage of cures. It is perhaps significant that in regard to oestrogen therapy some of the best results were reported by the earlier workers (e.g. Kennedy[21]) and were obtained with preparations which we now realize contained relatively small amounts of oestrogenic principle. Moreover Winther[55, 63], has recently reported a series of 100 cases of dysmenorrhoea in university students and shows that the results obtained with emmenin (oestriol) were no better than those obtained in the control series treated with a placebo. Hoffman[10] says his experience is similar. There is therefore good reason to doubt whether oestrogen therapy has any special value in the treatment of dysmenorrhoea; if it has, and it acts by any of the mechanisms above, then its effect must still be a temporary one. These possible modes of action should be kept in mind when it is employed.

SUMMARY.

1. The pain of spasmodic dysmenorrhoea is related in some way to contractions of the uterus. The difference between painful and painless contractions lies in their character rather than their strength. The particular pattern of uterine motility causing pain during menstruation is unknown but the view which supposes incoordination of different areas of the uterus, or disturbed polarity of the uterus, has still to be disproved.

2. The theory which supposes uterine hypoplasia as the cause of the abnormal uterine contractions, and the evidence on which it is based are critically examined in the light of what is known about the development of the uterus.

3. An analysis of the histories of 829 patients suffering from spasmodic dysmenorrhoea shows:

(a) Not more than 27 patients had definite signs of uterine hypoplasia.

(b) The age of the menarche was usually within normal limits.

(c) Scanty and infrequent menstruation was exceptional and most women had a regular cycle.

(d) Endometrial studies in 111 cases showed, with 2 exceptions, that the histological phase agreed with the time in the menstrual cycle. Painful menstruation is usually ovular in type.

(e) 457 patients had some minor malformation or malposition of the uterus, but these faults are not accepted as an indication of hypoplasia.

(f) The existence of an interval between the menarche and the onset of dysmenorrhoea in a large percentage of cases is confirmed. This in itself is evidence against the hypoplasia theory.

4. An analysis of a second series of 86 patients, all of whom had a hypoplastic or atrophic uterus, shows that of the 28 women who were menstruating only one had dysmenorrhoea of an incapacitating degree.

5. The effect of oestrogen on a hypoplastic uterus depends on the ability of the organ to respond. If the uterus is insensitive then oestrogen therapy is useless. If, however, the uterus is sensitive then there is no point in increasing its size temporarily unless the cause (usually ovarian underactivity) is corrected. Furthermore, if the cause is successfully treated, the hypoplasia is automatically cured and oestrogen is unnecessary.

6. The value of oestrogen therapy in spasmodic dysmenorrhoea is open to question. If it does give relief, albeit temporary, then it does not necessarily do so by overcoming hypoplasia. Several other possible modes of action are listed.

7. Throughout this paper we have deliberately adopted a critical and provocative attitude. The evidence is insufficient to prove or disprove the hypoplasia theory of dysmenorrhoea and it will remain so as long as the pathology of uterine hypoplasia is in doubt and its diagnosis depends on the opinion of individual clinicians. By setting out the facts as we see them we have endeavoured to draw attention to the need for a careful appraisal of the diagnosis and significance of uterine hypoplasia and atrophy, and for a sober outlook on the possibility of its successful treatment with oestrogens.

In conclusion we should like to express our indebtedness to the members of the Honorary Staff at the Women's Hospital, Liverpool, who have willingly allowed us to study and utilize the records of their patients.

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The Uncomplicated Primigravid Breech

A Technique Used in a Series of 60 Cases.

BY

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A SERIES of 60 cases of primigravid breech presentations delivered vaginally is presented. They constitute a consecutive series of cases delivered personally at Dilston Hall Maternity Hospital, Northumberland (48 cases); at Stagshaw House Maternity Hospital, Northumberland (6 cases); and St. Helier County Hospital, Carshalton, Surrey (6 cases). The series, though small, has added interest in that it was conducted with a definite plan of campaign and carefully considered technique.

For the purposes of this series I have defined the uncomplicated primigravid breech case as occurring in a woman pregnant of a live baby weighing 5 pounds 8 ounces or over and having neither (a) multiple pregnancy, (b) placenta praevia, (c) gross prolapse of the umbilical cord, (d) accidental "toxic" haemorrhage, (e) eclampsia nor (f) monstrosity. Two cases of grossly contracted pelvis are not included in this series, both having been delivered by Caesarean section. One of these was an elective section for severe flat pelvis—patient aged 33—the other, an emergency admission, had a lower segment section for obstructed labour, the breech not being engaged after 4 hours at full dilatation with membranes ruptured for many hours and an awkward android pelvis. Caesarean sections were not performed for elderly primiparity. All cases available, whether booked, unbooked or emergency, have been included.

The result of 60 vaginal deliveries in uncomplicated primigravid breech cases was 1 stillbirth and no neonatal deaths.

GENERAL DISCUSSION.

The disastrous results in vaginally delivered primigravid women have been frequently publicised in America and Britain by de Normandie, Schwartz, Irving, Goethals, Gibberd, Moir and others. The whole literature was adequately reviewed by Racker,[1] and it is not proposed to recapitulate it. The great volume and authority of this propaganda has had two marked effects in the last 10 years; first there has been a movement towards breech extraction under full anaesthesia and second, there has been increased employment of Caesarean section especially in private practice. Goethals,[2] working on a special assignment at Boston Lying-in Hospital, delivered all breech cases, primigravid and multigravid, by breech extraction under full anaesthesia. The results have been excellent and in the past decade they have reduced the foetal loss in mature breech cases to 5 per cent. These, of course, are men of unparalled experience working with expert anaesthetists who can assure genuine full surgical anaesthesia with minimal anoxia of the foetus. The process of training assistants and juniors to their high degree of skill is likely to be costly in foetal life and few aspirants may succeed in equalling the masters. The necessity for full anaesthesia alone must weigh against the baby especially after long

labour and possible intrapartum sedation. Schwartz, quoted by Goethals, compromised by recommending that all complete and footling breeches should be delivered by extraction under anaesthesia, leaving frank breeches to spontaneous delivery with minimal manual aid.

The practice of performing Caesarean delivery for the uncomplicated breech with an adequate pelvis is to be deplored. Recent writers have widened their indications for abdominal section even to the extent that a primigravida over the age of 30 is classed as "elderly." I find that I am now asked by general practitioners to perform Caesarean section on their primigravid breech cases for the thinnest of indications, as age, nervousness, hard perineum, hypertension, absence of husband on war service, apparently regardless of the fact that the maternal risk of an abdominal delivery is at least 5 times that of a vaginal delivery. Neither should it be forgotten that many patients, for reason of fear or expense, commit themselves to what can be called One-child Caesarean Sterility.

This paper is written to show that there is another side to the medal. An increasing number of satisfactory series has been reported and reasonable figures are being turned out both in public and private practice. Marshall[3] reported a series of 36 normal primigravid breech cases with 1 loss. Macafee and McClure[4] have reported a foetal loss of only 4.84 per cent in a corrected series of booked primigravidae. The Simpson Memorial Hospital Report for 1942[5] shows a corrected, booked primigravid foetal loss of 5.8 per cent. Urnes and Timerman,[6] reporting the practice of the Chicago Lying-in Hospital district cases, showed a corrected foetal loss of 6.6 per cent for all breeches—these cases were delivered in the patients' homes by junior officers using local pudendal anaesthesia and aiming at spontaneous delivery. Patton and Mussey[7] report a foetal loss of 5.34 per cent for uncomplicated primigravid cases. The best series I have been able to find is that reported by Hansen.[8] With H. S. Morgan he has personally conducted a series of 64 uncomplicated cases. Their treatment has been extremely conservative and appears to have been minimal manual aid applied only when labour has been held up. They lost 1 baby in the 64 uncomplicated cases. In the same period 48 multiparae (uncomplicated) were delivered without any loss. Their conservancy is illustrated by the fact that the longest 1st stage of labour was 57 hours and the longest 2nd stage was 7¼ hours. In 126 total deliveries they employed manual aid 109 times, extraction 13 times and Caesarean section 4 times. Only 2 Caesarean sections were employed for elderly primigravidae with large babies, each weighing over 9 pounds.

Tompkins[9] reports a unique series collected over 10 years from the Philadelphia Lying-in Hospital. From the records of 1,400 breech cases he selected *every case personally delivered* by 17 obstetricians "certified" by the American Board of Obstetrics and Gynecology. The resultant series of 211 cases was "corrected" by subtracting the premature infants, monstrosities, severe toxaemias, placenta praevia cases, twins and Caesarean sections. In the "corrected" series of 146 cases, there were only 4 babies lost—a mortality-rate of 2.7 per cent. When a further correction was made to include private patients only there were 2 losses in 139 cases. He does not extract the figures for primigravidae only. In the total of 211 cases it is noted, however, that there were no less than 31 cases delivered by Caesarean section. The technique is not described but in general it seems that the patients are "fully anaesthetized" before delivery.

It would appear, therefore, that vaginal delivery of the breech case can be made to give satisfactory results. The three outstanding series by Marshall, Hansen and Tompkins show good results by different methods. The common factors in their success are a good psychological approach, careful preliminary study, a definite, reasoned programme, and the ability at any moment in any case to carry out a smooth extraction when this is demanded.

Method of Delivery.

The physician confronted with an uncomplicated primigravid breech case has the choice of 3 methods of delivery:

1. Caesarean section.
2. Breech extraction with full anaesthesia.
3. Spontaneous delivery with minimal manual aid.

(1) *Caesarean Section.*

It is obvious that there must be a greater place for Caesarean section for a breech presentation than for a vertex presentation in the primigravida. Trial labour is completely eliminated. The borderline case, particularly with trouble in the mid-pelvis or at the outlet, must receive the benefit of elective section. Full examination of the pelvis, if necessary under an anaesthetic, is indicated. Radiography with pelvimetry can be used to check clinical findings.

Caesarean section should also be elected when the baby is obviously large. The mortality-rate for babies over 8½ pounds rises very steeply.[1, 2] The combination of elderly primiparity and large baby is not uncommon.

Elderly primiparity by itself should seldom lead to Caesarean section. A great deal depends on the state of "ripeness" of the cervix at the time of the onset of labour. In my experience the condition of the lower uterine segment, cervix and upper vaginal tissues are of much greater importance than the perineum. The resistance of the last can largely be eliminated by anaesthesia, stretching and episiotomy. The combination of a thick, tubular, unripe cervix, hypertension and a longish period of sterility, with or without obesity, strongly indicates Caesarean section.

One last group of cases also merits abdominal section—cases with premature rupture of membranes, a high unfixed breech and a closed elongated cervix without early onset of effective labour. A final verdict on this type of case should be made before the membranes have been ruptured for over 24 hours.

(2) *Breech Extraction.*

Breech extraction can be elected for all breech cases as in the practice of Irving, Goethals and Potter. Excellent results can be obtained by the very experienced operator working with a skilled anaesthetist. Failure is most likely to be due to insufficient ironing-out of the perineum and lower vagina or inadequate anaesthesia. Gas and oxygen are insufficient and the more depressant anaesthetics must be used in full dosage. It should be remembered that the mother, particularly the exhausted or toxic mother, may not be fit for this ordeal, and the effect on the baby should also be considered. Every operator approaching any breech delivery may be called on, at any time, to make a breech extraction for such indications as arrest, foetal distress, constriction ring or prolapse of the umbilical cord; but that is a very different matter from deliberately planning a dangerous and exacting operation for a series of cases, at least 90 per cent of which could terminate spontaneously or with minimal manual aid.

(3) *Spontaneous Delivery with Manual Aid.*

The ideal delivery is spontaneous. The majority of breech cases in multiparae can

be so delivered. It is interesting and instructive to leave such a breech delivery entirely to itself and, with the mother in the lithotomy position, to watch the crowning, the upward lateral flexion, the restitution, the downward flexion, the smooth but sudden rotation of the back upwards and birth to the umbilicus. The baby can still be left untouched. By the mother's expulsive effort aided by the baby's weight, delivery can proceed still further. The baby rotates a little, the body advances, the anterior scapula appears, slides downwards and inwards towards the spine and often the arm and hand appear spontaneously. The body restores itself again and the other scapula appears laterally to be followed by arm and hand. The baby, still left untouched, hangs by the head in the Burns-Marshall position, the neck elongates, showing that the head is in the pelvis, and all that is left is to elevate the body and lift the head off the perineum. In the majority of multiparous cases the breech delivery is quicker, smoother and less painful than vertex delivery.

The problem, as it appears to me, is how to make conditions in the primigravida approximate to the delivery in multiparae: (a) how to get the uterus into full activity at the proper moment, (b) how to have the cervix fully dilated and withdrawn, (c) how to reduce the barrier of the vulva and perineum, (d) how to deliver the arms with minimal handling of the baby, and (e) how to reduce trauma in delivering the head. In my own series of 60 cases, I have performed breech extractions 5 times only. All the other patients have had minimal and very late manual aid. Recently I have been able, in most cases, to keep my hands off the baby entirely until the first scapula has appeared. In reaching this limit of non-interference, I have found the greatest assistance from the following technical lines.

(*a*) Preparation of the patient.
(*b*) Perineal and pudendal nerve block.
(*c*) Preparation of vulva and perineum by "ironing-out." This is followed by posterolateral episiotomy.
(*d*) The Lövset technique of delivery of arms.
(*e*) A short rest in the Burns-Marshall position.

(a) *Preparation of the Patient.* Defective uterine action is very common among primigravidae. This accounts for a large proportion of instrumental deliveries in normal, as well as in occipitoposterior vertex cases. It has to be avoided as far as possible if the breech delivery is to be near-spontaneous. Prophylaxis begins early. The patient need not be informed of the breech presentation, or if she is aware of it, the import of it can be minimized. She is examined soon after the onset of labour with special attention to the condition of the cervix. If the cervix is fully ripe, thin and well taken up, mild sedation by heroin, pethedine, or by an opium-chloral-bromide mixture will probably suffice. If the cervix is still a thick tube, sufficient heavy sedation by morphine-scopolamine is indicated to ensure at least one good sleep. If the patient has had a few wakeful nights with prodromal signs of labour, intramuscular paraldehyde (10 c.c.) is well worth adding.

Later, one may attempt to regulate disordered or poor uterine action by calcium gluconate, oestrogens or intravenous glucose. In brief, one tries to bring the patient into the best possible condition when full dilatation is arrived at. To this end, the patient is not encouraged to bear down until the perineum is being well bulged. It should not be assumed that because a foot or knee or even a buttock is showing that the cervix is fully dilated. Often it is not. Wait until the breech is really at the vulva and actively dilating it

before proceeding further—usually by this time the patient is badly wanting to bear down.

(b) *Perineal and Pudendal Nerve Block.* The perineum being now distended by the advancing breech, the patient is put in the lithotomy position, cleansed, disinfected and draped. Local anaesthesia is induced. The method is easily learned and can be found described by De Lee,[10] Brentnall,[11] and Griffin and Benson.[12] I find that 100 c.c. of 0.5 per cent procaine is sufficient. The solution contains 1 in 200,000 of adrenalin, but this can be omitted.

(c) *Ironing-out: Episiotomy.* In a few minutes the patient is greatly relieved and the vulva and perineum are ready to be ironed out. This can be done slowly and leisurely as labour is usually temporarily checked, possibly by adrenalin effect, and the patient is no longer subject to involuntary bearing down. During this period of calm, the patient should now have it explained to her that a special effort is required of her and that she should bear down in a very determined manner when the signal is given. When labour is resumed, strong down-bearing takes place, the breech advances, and now considerably bulges out the relaxed perineum. When the breech is about to crown a postero-lateral episiotomy is made. If the episiotomy is well-timed the breech is delivered in a few seconds and immediately before this event is due I have found it useful to give 3 units of pitocin intramuscularly. In more than half of my cases the delivery of the baby from the birth of the buttocks to well past the umbilicus has taken place during one uterine contraction.

The baby is still not touched and there is no need to disengage the feet of the usual frank breech. The baby's weight comes into play and birth as far as the scapulae without any interference is common.

(d) *The Lövset Manoeuvre.* This manoeuvre, described by Lövset,[13] enables one to extract shoulders and arms in nearly all spontaneous deliveries without intravaginal manipulation. In the case of a left sacral anterior, when birth is well past the umbilicus, the baby, carefully splinted between both hands applied along the whole length of its visible body, is drawn slightly downwards and towards the mother's right and at the same time rotated slowly in a counter-clockwise direction. In this way, while descending, the posterior shoulder becomes lateral or frankly anterior. When the scapula appears it is pushed strongly towards the spine with the free index finger of the right hand. Usually the elbow, shoulder and hand (in that order) appear from the vulva. The baby is then drawn towards the mother's left side with slight traction and a slow rotation is made clockwise so that the baby's retained shoulder, which had become posterior, is restored to its original anterior position. While rotating, the shoulder and arm nearly always appear spontaneously. The baby is then released and allowed to hang by the head for about 20 seconds.

(e) *The Burns-Marshall Position.* The Burns-Marshall technique is very effective in flexing the head and by its gentle weight traction it nearly always draws the head well into the pelvic cavity. It also has a most effective teaching value. There is no better means of teaching students and midwives that hurry has no place in breech delivery; this 20 seconds relief from tension and apparently nonchalant approach to the final step in delivery is a most pointed lesson. It is probably good for the obstetrician too.

In this series I have used the Mauriceau-Smellie-Veit technique for delivery of the head. This manoeuvre I apply only once. If there is failure to get immediate easy extraction, the baby's feet are taken over

by an assistant and the forceps are applied to the after-coming head. The forceps were used for the head in 17 of this series of 60 cases.

In the last 2 years I have abandoned general anaesthesia for delivery of the after-coming head. It is quite unnecessary with a good pudendal nerve block.

In the occasional event of failure to induce the head into the pelvis by the Burns-Marshall position, the Weigand-Martin technique as described by De Lee[14] is used, followed by the forceps, applied after the head is well down.

What to Avoid.

It one has elected for a spontaneous delivery with minimal manual aid, the patient should be watched and nursed to this end. The final preparations of local anaesthesia, ironing-out and episiotomy, are not made until the breech is completely down and bulging the perineum. The episiotomy is made late to avoid blood loss. If the local anaesthesia has been made prematurely and if the uterus is sluggish, one can always wait for the ideal moment. If necessary the local anaesthetic can be repeated. The majority of mistakes arise from hastening matters when a buttock, foot or knee is just showing. The cervix may not be fully dilated and withdrawn. Hastening (or assisting) matters when the patient is not ready, leads to the old-style assisted breech delivery. Fingers, tapes or instruments are hooked into the anterior groin, later into both groins. Next the buttocks or legs are drawn down against resistance. The patient suffers pain, panics and struggles. The whole genital canal begins to feel like a recalcitrant sphincter. A rushed anaesthetic is induced, there is more straining, more spasm, the baby's body becomes whitened and limp from the shock of handling and traction, and is as good as dead before the arms have been secured—one has been caught in the half-way house, in something which is neither a breech extraction under surgical anaesthesia nor a spontaneous delivery with minimal aid.

It may be that at any time the plan for a spontaneous delivery has to be abandoned; maternal exhaustion, uterine inertia or maternal nervousness with inability to co-operate may negative the plan. Harm will not have been done if the local anaesthesia, ironing-out and episiotomy have all been prepared. The patient can then have full surgical anaesthesia induced without haste, flooding her with oxygen the while. When the anaesthetist is ready, a deliberate breech extraction is made.

It is noted that Hansen attributes his brilliant results to waiting patiently for spontaneous delivery and interfering (or aiding) as little as possible . He quotes his longest 2nd stage as $7\frac{1}{4}$ hours. My own limit has been 10 hours—in the 60th case of this series. The mother was comfortable for the most part of the time having only weak, irregular contractions and the baby was in no way distressed by the long wait. Extreme slowness does not imply obstruction.

Clinical Details of this Series.

Sixty cases were delivered vaginally.

Fifty-five had spontaneous delivery with minimal aid.

Five cases had full breech extraction, the indications being:

(*a*) Impacted breech, arrested progress 2
(*b*) Cardiac disease 1
(*c*) Nervous patient 2

Anaesthesia for Impacted Breech:

Full chloroform and oxygen ... 3
Spinal anaesthesia 2

Episiotomy. Every case had a postero-lateral episiotomy.

Forceps on aftercoming head applied in 17 cases (28 per cent).

Premature rupture of membranes occurred in 18 cases (30 per cent).

Duration of labour:

1st stage, average 14 hours. Longest 43 hours, shortest 3 hours.

2nd stage, average $1\frac{1}{3}$ hours. Longest 10 hours, shortest $\frac{1}{4}$ hour.

Maternal mortality. Nil.

Maternal morbidity. Nil.

Stillbirths 1. Died of cerebral damage, with depressed fracture of the posterior parietal bone. This case was misdiagnosed as a vertex until well advanced in labour. Pinard's manoeuvre and breech extraction were made under full anaesthesia after 42 hours in labour, marked by disordered uterine action. The baby weighed 9 pounds. This case should have had Caesarean section. This was the second case of the series.

Neonatal deaths. Nil.

Neonatal morbidity. One case appeared to have some cerebral irritation. It was admitted to Newcastle Babies' Hospital, made a good recovery and is now, at 12 months of age, regarded as a normal baby.

Birth injuries. One case of fractured left clavicle. The same baby had a temporary right Erb's palsy which was cleared up in a week. Both arms had normal function before it left at 18th day. It is believed that in this case the damage was done by the forceps which were badly applied.

Delivery of the arms. The 5 cases of breech extraction all required intravaginal manipulation to disengage the arms. The writer favours the Lövset manoeuvre of rotating the infant's body so that the posterior arm is brought into an anterolateral position when it is usually easily swept down by fingers introduced, over and beyond the shoulder, from the posterior aspect. The reverse rotation is then made to secure the second arm anteriorly.

In the remaining 55 cases of spontaneous delivery, only 6 cases were rated as difficult in so far as they did require high vaginal interference for delivery of arms and shoulders on orthodox lines. In the other cases the arms were practically completely disengaged by the Lövset rotation alone. Nuchal positions of arms were not encountered.

Ages of patients. The range in ages was from 17 to 40. Both extremes had spontaneous delivery.

Ten patients were in the age group 30 to 34; 5 patients were in the age group 35 and over. All in these two age groups had spontaneous delivery.

Type of breech presentation. Two cases were footling breech; 3 cases were complete breech; 55 were frank breech.

Summary.

1. Sixty cases of vaginal delivery of the uncomplicated primigravid breech are presented. Delivery was accomplished with 1 foetal loss. The last 58 cases were delivered without any foetal loss.

2. The wide use of Caesarean section for the uncomplicated primigravid breech is deprecated.

3. It is suggested that only two distinctly separate techniques are permissible—(a) Deliberate breech extraction under full anaesthesia and (b) Spontaneous breech delivery.

4. It is maintained that the common assisted breech delivery with induction of anaesthesia gradually brought in during delivery falls between the two methods and exhibits the virtues of neither.

5. The writer believes that fully 90 per cent of primigravid breech deliveries can be spontaneous.

6. A technique of spontaneous breech delivery is outlined.

I have to thank Dr. J. B. Tilley, County Medical Officer to the Northumberland County Council, for permission to use the records of Dilston Hall Maternity Hospital for the purposes of this paper, and Dr. J. Ferguson, County Medical Officer to Surrey County Council, for permission to include 6 cases from St. Helier County Hospital, Carshalton, Surrey.

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The Relation of Vitamin B_1 Deficiency to the Pregnancy Toxaemias

A Study of 371 Cases of Beri-beri Complicating Pregnancy

BY

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FOR many years it has been suggested that a causal relation exists between dietary deficiency and the toxaemias of pregnancy. During the first world war it was noted in Germany that the partial elimination of protein and fat from the diet of pregnant women was accompanied by a 50 per cent decrease in the incidence of eclampsia. It has been customary to ascribe this lowered eclampsia rate to the sparse intake of animal protein, but it has also been suggested by De Lee[1] that lack of meat forced the patients to resort to a diet containing relatively large amounts of vegetables, black bread, etc., and that their vitamin B_1 intake was correspondingly higher than usual. In 1935 Theobald[2] advanced his dietetic theory of the causation of pregnancy toxaemia, or what he preferred to call the "Atelositesis of Pregnancy." He ascribed the condition to a deficiency in calcium, iron, iodine and vitamins of the B and D groups, and produced striking clinical evidence of his contention.

In 1938 Siddall[3] suggested that a deficiency in vitamin B_1 was the basic aetiological factor in the causation of the various pregnancy toxaemias. In his view the normal function of the pituitary body can only be maintained in the presence of an adequate supply of vitamin B_1. In the non-pregnant woman a deficiency of the vitamin causes hypofunction of the pituitary body, followed by oedema, lowered blood pressure, disturbed carbohydrate metabolism, and the other characteristic features of beri-beri. In the pregnant woman Siddall's view is that vitamin B_1 deficiency results in over-compensation or malignant hyperfunction of the pituitary gland, thus producing the symptoms of toxaemia, such as oedema, nausea, vomiting, increased blood-pressure, disturbed carbohydrate metabolism, etc. Siddall suggested that an adequate and constant supply of vitamin B_1 should prevent and possibly cure the toxaemias of pregnancy. This new concept for the first time harmonized all the conflicting manifestations of the toxaemias of pregnancy.

H. Yasunami[4] also gave vitamin B_1 treatment to patients with hyperemesis gravidarum, pre-eclampsia and eclampsia. The patients were not given any other treatment and usually recovered rapidly. He expressed his belief that the administration of vitamin B during pregnancy would prevent the toxaemias of pregnancy and that patients with existing pre-eclampsia would not develop eclamptic convulsions.

W. Spitzer[5] and F. C. Irving,[6] in further communications, have stressed the value of vitamin B_1 and the vitamin B complex in the treatment of hyperemesis gravidarum.

During the years 1938 and 1939[7] an important study was made of the records of 5,022 pregnant women attending 10 London Hospitals. A dietary deficiency was found in more than half of the patients. In 1,530 primigravidae receiving vitamins and mineral supplements the toxaemia rate was 27.1 per cent as compared with a rate of 31.7 per cent in a control group of 1,512 primigravidae not receiving the supplement. The investigations into pre-natal diet at the Toronto General Hospital by Ebbs, Scott, Tisdall, Brown and others[8, 9] showed a pre-eclampsia incidence of 12.6 per cent in patients receiving a poor diet in comparison with an incidence of 9.1 per cent in the supplemented diet group and 7.8 per cent in patients receiving a good diet. By a good diet the authors specified: protein, 80 to 100 grm.; fat, 80 to 100 grm.; carbohydrate, 350 to 400 grm.; calcium, 1.5; iron, 0.020; iodine in iodised salt, together with vitamins A, 6,000 i.u., B_1 500 to 1,000 i.u., B_2 3 to 3.5 mg., C 50 to 75 mg., and D 500 to 1,000 i.u.

Further studies by Burke, Beal, Kirkwood and Stuart[10] showed a statistically significant relation between prenatal diet and the course of pregnancy. In their investigations no mother whose diet during pregnancy was considered "good" or "excellent" had pre-eclampsia, while with a "poor" to "very poor" diet almost 50 per cent had pre-eclampsia.

W.C.W. Nixon,[11] in his recent Blair-Bell Memorial Lecture, further stressed the importance of an adequate diet during pregnancy. In a previous investigation, Nixon, with his co-workers Wright and Fieller,[12] found that in 9 patients suffering from eclampsia there was a significantly low urinary output of vitamin B_1 as compared with normal control pregnant women. In these patients, also, the placenta was found to have a markedly low vitamin B_1 content. The authors found a highly probable correlation between suboptimal intakes of thiamine and the incidence of pregnancy toxaemia, and suggested that vitamin B_1 might be of value in the treatment of eclampsia.

Williams and Fralin[13] also observed that 84 per cent of a group of patients who presented a history of nausea and vomiting in early pregnancy had a vitamin B_1 intake definitely below the pregnancy standard of 600 units daily. These authors did not, however, feel justified in assuming that there was "any positive relationship between dietary adequacy and the occurrence of certain complications of pregnancy and childbirth."

Other writers, indeed, have seriously questioned the relation of vitamin B_1 to pregnancy toxaemia. F. J. Browne[14] conducted an investigation on a group of 169 pregnant women, of whom 88 were treated cases and 81 were controls. The 88 treated cases received by mouth 3 mg. daily of vitamin B_1 during the latter half of pregnancy. Of these patients 7.9 per cent developed a blood-pressure of 140/90 or over (or a blood-pressure in excess of 130/70 with albuminuria) as compared with an incidence of only 4.9 per cent in the control series. The author concludes that, so far as the prevention of pregnancy toxaemia is concerned, no beneficial effect is obtained by supplementing the diet with vitamin B_1. Another study by R. Kapeller-Adler and J. A. Cartwright[15] revealed that in 4 patients suffering from mild toxaemia of pregnancy there was no improvement under vitamin B_1 therapy, whereas in 3 cases of severe toxaemia the condition actually became worse. As the result of this unfortunate experience the authors stated their belief that the thera-

peutic use of vitamin B_1 in toxaemia of pregnancy should be discouraged.

The majority of recent clinical and experimental observations, however, would appear to support the belief that a definite relation exists between dietary deficiency and the toxaemias of pregnancy. There is a gaining weight of evidence that the deficiency is notably, if not specifically, one of vitamin B_1 intake. It has been known for a long time that there is a greatly increased need for vitamin B_1 during pregnancy. In 1927, Moore and Brodie[16] estimated that rats require four times the amount of vitamin B^1 to ensure the successful conclusion of a pregnancy than they do at other times. McCance, Widdowson and Verdon-Roe[17] found, in an investigation of 120 pregnant women, that all were receiving sub-optimal amounts of vitamin B_1. The estimated daily intake, even including patients from the higher income groups, varied from 209 to 454 i.u., as compared with an optimal daily intake of 600 to 900 i.u.

More recently Lockhart, Kirkwood and Harris,[18] in a very interesting communication, have produced concrete proof of an increased quantitative requirement for vitamin B_1 during pregnancy. These authors studied the quantity of thiamine needed by their patients to produce the same excretion status on successive lunar months during late pregnancy and the early puerperium. They found that in the 10th lunar month of pregnancy a patient requires three times as much thiamine as in the non-pregnant state to reach the same excretion peak. They also found that approximately three times as much thiamine was required by mouth as by the intramuscular route to reach the same excretion peak in non-pregnant subjects, thus indicating the relative efficacy of the two common methods of administration. The authors conclude that the requirements for thiamine during pregnancy and lactation are three times as great as in the normal non-pregnant state.

During the years 1939, 1940 and 1941 the writers had an unusually favourable opportunity, in Hong Kong, of observing the course of pregnancy in a large series of patients who were suffering from vitamin B_1 deficiency. True beri-beri, or avitaminosis B_1, was found in many of these cases, and hypovitaminosis B_1, or "sub-clinical beri-beri," was probably present in a much larger number, although clear evidence was often lacking, save for the frequent existence of oedema of the legs. An investigation into the clinical significance of oedema during pregnancy was commenced by one of the writers in conjunction with Professor W.C.W. Nixon in 1937, and was continued by the writers of this paper from the end of 1938 up to the time of the Japanese occupation of Hong Kong in December 1941. The following extract from the Report of the Department of Obstetrics and Gynaecology of the University of Hong Kong for the year 1939[19] indicates the lines upon which the investigation was proceeding:

> The existence of avitaminosis B_1, or beri-beri, is a complicating factor which is always to be reckoned with in obstetrical practice in Hong Kong. A fresh table is added to this year's report in which certain details are given of 49 clinically obvious cases of avitaminosis. It will be noticed that in 2 cases avitaminosis B_1 was the immediate cause of death, and that in 4 other cases it was a contributory cause. Avitaminosis therefore ranks very high as a cause of maternal death in Hong Kong, being present as a primary or secondary cause in 6 out of the 17 deaths for the year.
>
> Poverty, improper dietary habits and the additional strains imposed by pregnancy are all potent factors in producing vitamin deficiency. Clinical beri-beri is the result in only a minority of cases, but what may be termed sub-clinical beri-beri is present in a large number of patients. These patients live on a dangerous border-line, and many factors, of little consequence in themselves, may suffice to precipitate the patient into a condition

of clinically developed avitaminosis. It will be noticed that pregnancy toxaemia, in one form or another, is a complicating factor in a number of cases of avitaminosis B_1. The line of demarcation is one that is difficult to draw and it may still prove that deficiency of vitamin B_1 is a causative factor in the production of the toxaemias. The amount of pyruvic acid in the blood has been used as an index of vitamin B_1 deficiency, and investigations are proceeding along this line in the hope that this relatively simple biochemical determination may shed light upon the relationship between the toxaemias of pregnancy and vitamin B_1 deficiency.

An investigation into the clinical significance of oedema during pregnancy was commenced by my predecessor Professor W. C. W. Nixon, and may throw further light upon the problem just mentioned. During 1939 a special record was kept of all cases showing oedema and it is found that they may be classified into three main groups:

(*a*) Those associated with pregnancy toxaemia,
(*b*) Those associated with avitaminosis B_1, and
(*c*) Those not accompanied by signs of either pregnancy toxaemia or avitaminosis B_1.

In this latter group there were 271 cases. In the vast majority of these the oedema was limited to the legs, and the duration varied from a week to 9 months, the average duration being 44.5 days. The oedema was, therefore, by no means a transient symptom. In some patients pressure was undoubtedly a factor in producing the oedema, as evidenced by the fact that there were no fewer than 9 twin pregnancies among the 271 cases. In other cases, however, it could not be claimed that pressure was a specially significant factor. In view of the frequency of the toxaemias of pregnancy (6.01 per cent of all admissions for 1939) and of avitaminosis B_1 (1.47 per cent of all admissions for 1939), in both of which conditions the presence of oedema is almost invariable, it is hard to resist the conclusion that, in many cases, the appearance of simple oedema may be only a preliminary to the development of the full manifestations of toxaemia on the one hand or of avitaminosis B_1 on the other, and it is not beyond the realm of possibility that all three are bound up in a common aetiology.

The year 1940 brought with it an increased incidence of beri-beri and an alarming increase in the more severe forms of pregnancy toxaemia, as indicated in the following extracts from the Report[20] for 1940:

> The abnormal conditions mentioned in last year's report have continued to prevail in the Colony during the year 1940, with an almost unimaginable state of overcrowding, malnutrition and distress among the lower classes from which most of our patients are drawn. There has been a grave increase in the amount of beri-beri, as will be seen from a perusal of the special table devoted to this disease. The table includes only the 155 cases of clinically obvious beri-beri, and among these cases there was a death-rate of 11 per cent, in spite of intensive treatment with vitamin B_1 preparations. There were many more cases of what might be termed "sub-clinical beri-beri" in patients living on the extreme border-line of the state to which poorness of nutrition was inevitably driving them, and there is no doubt that, if present conditions continue to prevail, we must expect a still further increase of avitaminosis B_1.
>
> The classification of the toxaemias of pregnancy has been continued on the same basis described in last year's report, with satisfactory results. The frequent association of this condition with signs of avitaminosis B_1 during the year has again been noted, and biochemical studies have been continued . . . and will form the subject of a publication in the near future. The most alarming feature of the year's work was the occurrence of what might almost be described as an epidemic of eclampsia. There were 42 cases of this disease, as against 8 cases for the previous year. The severity of the disease was very marked and many of the worst cases were of the post-partum variety. There was a death-rate of 30 per cent among these patients, considerably more than half of which was due to complicating beri-beri and consequent heart-failure.

During the year 1941, for which only a manuscript report is available, conditions remained very much on the same level as in 1940, and the striking coincidence of a maintained increase in the total number of cases of beri-beri and a continued rise in the number of patients suffering from pregnancy toxaemia could not fail to strike the most casual observer. In Table I the inci-

dence of beri-beri complicating pregnancy during these three years is shown.

TABLE I.
Incidence of Beri-beri Complicating Pregnancy in Hong Kong, 1939-41.

Year	Cases of beri-beri	Total admissions	Incidence per 1,000
1939	49	3,328	14.71
1940	155	4,738	32.71
1941	167	3,541	47.16
Totals:	371	11,607	31.10

The incidence of the toxaemias of pregnancy during the same period is shown in Table II.

TABLE II.
Incidence of the Various Forms of Pregnancy Toxaemia in Hong Kong, 1939-41.

Type of Toxaemia	1939	1940	1941	Total
Pre-eclampsia, Grade I	112	128	221	461
Pre-eclampsia, Grade II	63	114	151	328
Eclampsia	8	42	29	79
Nephritic toxaemia ...	4	4	2	10
Hypertensive disease ...	13	4	13	30
Totals:	200	292	416	908
Incidence per thousand:	60.09	61.63	117.48	78.22

In studying Table II it is necessary to have some knowledge of the criteria upon which the classification of the toxaemia cases was based. After a careful study of the question, the classification shown in the appendix to this paper was adopted. It is based upon the recommendation of a Sub-committee appointed by the American Committee on Maternal Welfare in 1937 for the special study of the subject and agreed upon at the Annual Meeting of that body in June, 1940.[21]

It will be noticed that the first three conditions in the classification might be termed diseases dependent on, or peculiar to, pregnancy, whereas the last two belong to a group of diseases not peculiar to pregnancy. The classification was strictly adhered to in compiling the patients' case records and many cases with transient high blood-pressure or albuminuria were consequently not included in the toxaemic groups. The emphasis placed on the findings of albuminuria on more than one occasion and on the persistence of a raised blood-pressure of 130 mm. Hg. or higher for 2 days or longer ensures that only patients with genuine toxaemias were included, and also explains why a patient classified as suffering from pre-eclampsia, Grade I (mild), might be recorded as having a single maximal blood-pressure reading of over 150 mm. Hg.

In investigating the relation between avitaminosis B_1 and pregnancy toxaemia, extensive biochemical studies were conducted on all likely cases in addition to the usual clinical investigation. These studies included estimation of the carbon dioxide combining power, non-protein nitrogen, urea, uric acid, plasma proteins, chlorides, and pyruvic acid contents of the blood as well as parallel quantitative determinations of the vitamin B_1 content of both blood and urine. These observations were carried out on considerably more than 200 cases, but unfortunately, with the exception of the results of pyruvic acid determinations on 207 patients, the whole of the rest of the biochemical data was destroyed by enemy action in Hong Kong (it was actually in the process of being assembled for publication when the war broke out in December 1941). The data presented in this paper are therefore very largely based on the brief case summaries which had been prepared and which it has been found possible to salvage.

In further studying the case histories of patients included in Tables I and II it was found that 252 of them showed evidence that they were suffering from a combination of beri-beri and pregnancy toxaemia. In other words, of the 371 cases of beri-beri with which this paper is concerned, ap-

proximately 70 per cent were complicated by one or other of the forms of pregnancy toxaemia. Conversely, 28 per cent of the 908 cases of pregnancy toxaemia showed fully developed manifestations of beri-beri.

The combined incidence of beri-beri and pregnancy toxaemia is shown in Table III.

TABLE III.
Incidence of Pregnancy Toxaemia in 371 Cases of Beri-beri Complicating Pregnancy

Clinical condition	1939	1940	1941	Totals
Beri-beri with normal pregnancy	32	47	40	119
Beri-beri with pre-eclampsia, Grade I ...	2	38	52	92
Beri-beri with pre-eclampsia, Grade II ...	12	52	58	122
Beri-beri with eclampsia	2	18	16	36
Beri-beri with nephritic toxaemia	1	—	—	1
Beri-beri with hypertensive disease ...	—	—	1	1
Totals ...	49	155	167	371

The findings shown in this table are very significant, and they are shown in graphic form in Fig. 1, which brings out clearly not only the increase found in the total number of cases of beri-beri during the 3 years, but the relative increase in the incidence of complicating pregnancy toxaemia during the latter 2 years. It might be argued that the increase is apparent rather than real and that the true state of affairs can only be appreciated by considering the facts in relation to the number of cases admitted to the wards. Fig. 2 has therefore been prepared showing the incidence of pregnancy toxaemia, beri-beri and the combination of both conditions per 1,000 cases admitted to the obstetrical wards. Since the total number of admissions for the year 1941 was less than that for 1940, this method of representing the position shows even more clearly the striking bond which appears to exist between an increase in the beri-beri rate on the one hand and an increase in the toxaemia rate on the other, a bond which is still further strengthened by the co-existence of the two conditions in a significant number of cases.

CLINICAL FINDINGS.

The following summary of the clinical findings in the 371 cases which form the subject of this paper may be of interest:

(1) *Age* and *parity*. The group consisted of 125 primiparae (33.4 per cent), with an average age of 23.6 years and 246 multiparae (66.6 per cent), with an average age of 29.9 years. This distribution is almost exactly similar to that found in the total number of cases admitted, so that no special association was noted between the incidence of beri-beri and the age or parity of the patient. (This contrasts with the 908 cases of pregnancy toxaemia of whom over 66 per cent were primiparae.)

(2) *Twin pregnancy* was found in 15 out of the 371 cases of beri-beri, an incidence of 1 in 24.7. This compared with an incidence of 1 in 26.7 for the 908 cases of pregnancy toxaemia and a general incidence of 1 in 105.7 for all cases delivered during the same period.

(3) *Oedema*. Oedema was present in all but 13 of the patients, an incidence of over 96 per cent. The duration of the oedema ranged from a few days to 6 months, but averaged 44.77 days in the 371 cases. In many instances the oedema was the most conspicuous feature. It generally commenced in the feet and legs and extended upwards over the body, being usually very noticeable in the abdominal wall. Ascites,

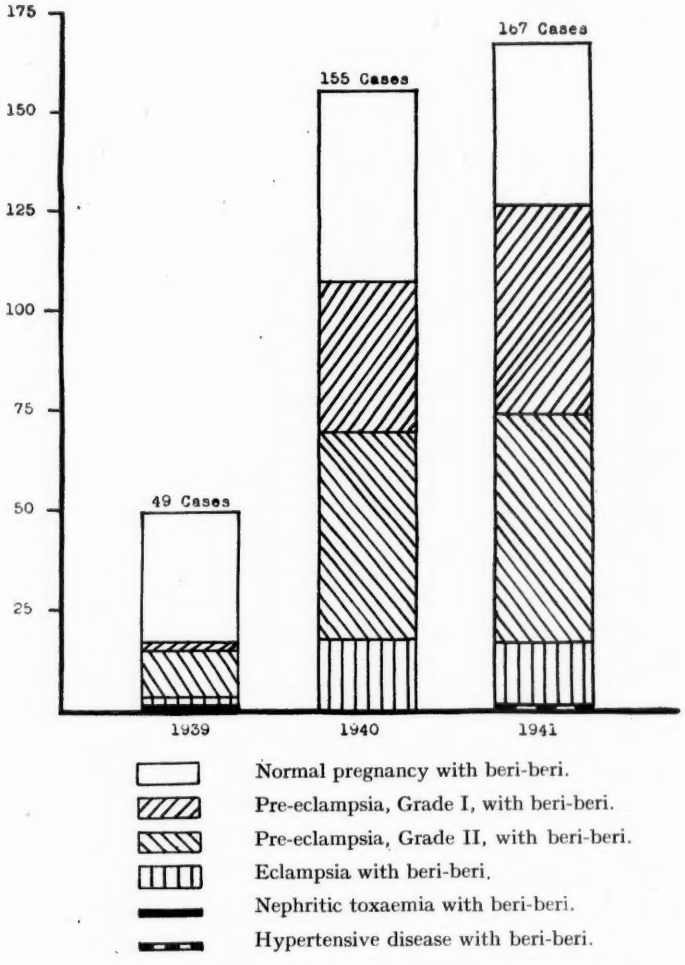

FIG. 1.

DISTRIBUTION OF 371 CASES OF BERI-BERI COMPLICATING PREGNANCY.
(Hong Kong, 1939 to 1941)

pulmonary oedema, hydro-thorax and hydro-pericardium occasionally developed. The latter was usually a prominent feature in the cases that came to post-mortem. It was generally the " wet " form of beri-beri, therefore, which was encountered in Hong Kong. In this connexion it is interesting to note that McCarrison believes that wet beri-beri occurs in partial and prolonged deficiency of vitamin B_1, and that the dry form occurs in complete absence of vitamin B_1.

(4) *Nervous changes.* The condition of the reflexes, the presence or absence of

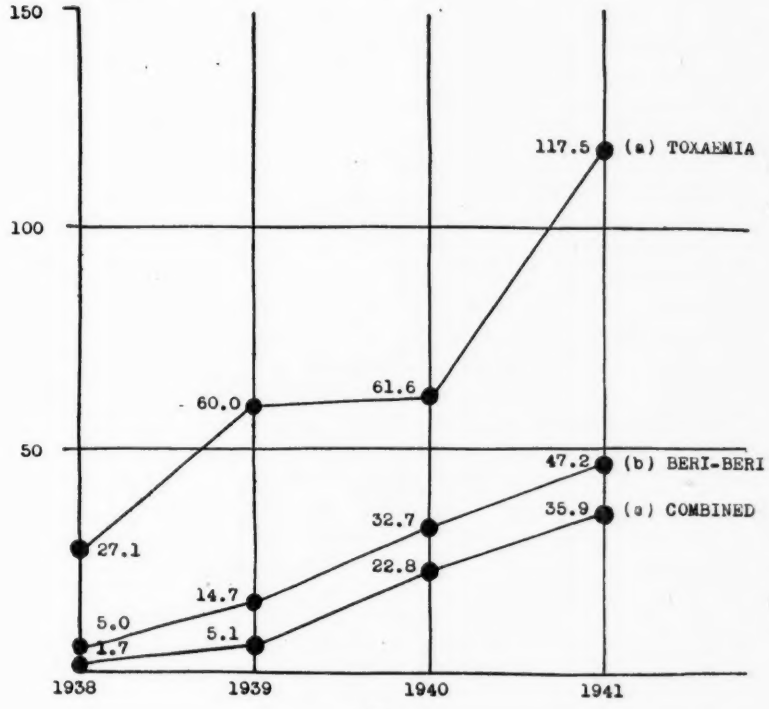

FIG. 2.

Showing rising annual incidence per thousand admissions of
(*a*) Pregnancy toxaemia; (*b*) Beri-beri; (*c*) Combined toxaemia and beri-beri.
(Hong Kong, 1938 to 1941)

anaesthesia, hyperaesthesia and muscular weakness or wasting was investigated in all cases.

The knee jerks and ankle jerks were found in rare early cases to be exaggerated, later to become weak and sluggish and finally to be completely abolished. The knee jerks were recorded as being exaggerated in 3 patients, present in 33, sluggish in 6 and entirely absent in 323 (there was no record in 6 cases). Areas of cutaneous anaesthesia and numbness were found in 65 cases. Hyperaesthesia, particularly sensitiveness to deep pressure over the calf muscles, was found in 149 cases. Muscle changes varied from slight wasting to marked atrophy, and, in the worst cases, an inability to walk. Such changes were present in 212 cases. There was no noticeable change in 110 cases, and records were not available in 49 cases. The muscles of the foot and calf were those usually affected, but later the extensor and flexor muscles of the thigh were involved, by which time foot-drop was often present. In more severe cases the arm muscles and the muscles of the trunk and even the diaphragm were sometimes affected.

(5) *Cardio-vascular changes* were those most to be feared in these cases. During pregnancy, and more especially as the time for the onset of labour approached, patients

were found to be peculiarly liable to develop cardiac symptoms, which were present in one form or another in 175 cases. Abnormal pulsation and thrill in the great vessels, with accentuation of the first sound, often with systolic and pre-systolic murmurs, were the commonest findings and were recorded in 139 cases. Cardiac dilatation was demonstrated by clinical and sometimes by X-ray examination in 99 cases, often with visible and palpable throbbing pulsations over the cardiac area, particularly to the left of the sternum. Symptoms of failure, such as dyspnoea, cyanosis, tachycardia, overdistension of the neck and arm veins with enlargement and pulsation of the liver were not infrequently noted. In patients developing acute cardiac failure the prognosis was always viewed with the utmost gravity in spite of the use of intensive vitamin therapy. In some 18 cases in this series death was directly due to heart failure. In the 14 other fatal cases cardiac failure was a terminal feature. In many further cases cardiac failure occurred, but was successfully treated by the exhibition of thiamine in large doses.

(6) *Blood-pressure.* The main stimulus for the present investigation was provided by the surprising discovery of a raised blood-pressure in numerous cases showing the otherwise well-marked signs of beri-beri. In beri-beri the blood-pressure is usually found to be lowered, but in this series of cases the highest systolic readings are shown in Table IV.

TABLE IV.
Systolic Blood-pressure Readings in 371 Cases of Beri-beri.

Systolic blood-pressure	No. of cases
Below 130 mm. Hg.	53
130 to 149 mm. Hg.	86
150 to 169 mm. Hg.	95
170 to 199 mm. Hg.	116
200 mm. or over	21
Total:	371

When these figures are compared with those shown in Table III it will be noticed that the patients with high blood-pressure readings roughly corresponded in number with those classified as suffering from pregnancy toxaemia. The figures also demonstrate that, among the 119 cases of beri-beri complicating an otherwise normal pregnancy, a considerable number of patients showed, at one time or another, a blood-pressure of over 130 mm. Hg., though in many instances the rise was not maintained for more than one day, and the case was therefore not placed in the toxaemia class. This inclination to show a rising blood-pressure might be interpreted as indicating that these patients had a tendency towards the development of toxaemia which was arrested by prompt treatment.

(7) *Urinary findings.* Albumin was not usually present in the urine of patients with normal pregnancy complicated by beri-beri. In the patients with pregnancy toxaemia, however, there were the usual findings of albuminuria, granular casts, etc.

(8) *Pyruvic acid.* It is unfortunate that the mass of biochemical data which had been collected for this paper was lost in the manner alluded to above. But the records of the pyruvic acid content of the blood in 207 cases have, by good chance, been recovered. The readings were taken shortly after the admission of each patient to the hospital and were as shown in Table V.

It will be recollected that pyruvic acid is an intermediate product of carbohydrate metabolism. Since vitamin B_1 is necessary as a catalyst for the removal of the waste products of carbohydrate metabolism, the amount of pyruvic acid present in the blood may be said, to some extent, to parallel the vitamin B_1 deficiency. Johnson and Edwards[22] found experimentally that the resting level of pyruvic acid in the blood is 0.18 mg. per 100 c.c. Sixteen minutes after exercise it increased to 0.60 mg. After 26

TABLE V.
Blood Pyruvic Acid Content in 207 Cases of Beri-beri.

Pyruvic acid per 100 c.c. of blood	No. of cases
Below 0.20 mg.	2
0.20 to 0.49 mg.	8
0.50 to 0.69 mg.	21
0.70 to 0.99 mg.	66
1.00 to 1.99 mg.	89
2.00 to 2.99 mg.	19
3.00 to 3.99 mg.	2
Total:	207
Lowest reading	0.11 mg.
Highest reading	3.60 mg.
Average reading	1.17 mg.

minutes it dropped to 0.41 mg. and after 40 minutes to 0.27 mg. Lu and Platt[23] in 1939 found that, for cured cases of beri-beri, the initial pyruvic acid level averages 0.53 mg., increasing to 0.79 mg. immediately after exertion, and falling to 0.56 mg. after 30 minutes. In subacute cases of beri-beri they found an initial level of 0.76 mg., rising to 0.85 mg. immediately after exercise and to 0.87 mg. half an hour later. In general it has been stated that a pyruvic acid reading of 0.70 mg. or higher is evidence in favour of a diagnosis of beri-beri. In view of these facts the above results may be regarded as highly significant. Only 31 cases showed a reading below 0.70 mg. and of these only 2 fell within the normal limits described by Johnson and Edwards. The great majority of the 207 cases showed resting levels of well over 0.70 mg. Some of the readings were very high and the average for all cases was 1.17 mg. per 100 c.c. blood.

RESULTS OF TREATMENT.

All patients in whom a diagnosis of beri-beri was made, including the toxaemia cases, were subjected to intensive therapy with vitamin B_1, in addition to the usual dietary and other measures of treatment. At first dosages in the region of 10 or 20 mg. of thiamine per day were given, but much larger doses were administered in the more severe cases as experience increased. Preparations were obtained latterly containing 60 mg. of thiamine per cubic centimetre, and in serious cases a dose of 60 mg., or more, was maintained daily until the acute symptoms subsided. The route of administration was usually intramuscular, although in acute cases of cardiac beri-beri the intravenous route was often chosen. Many patients received several hundreds of milligrams of the vitamin during their stay in hospital, and one case of severe pre-eclampsia, with cardiac failure and a blood-pressure of 198/112, received as much as 2,000 mg. during her course of treatment: she recovered eventually and gave birth to a living baby. In another case of cardiac beri-beri with pre-eclampsia the patient received a total of 1,700 mg. of thiamine: she recovered, but the baby was stillborn. Such instances could be multiplied, and it often became a problem as to what limit should be placed on the use of a relatively expensive drug in an effort to save an apparently hopeless case.

The results of treatment are shown in summarized form in Table VI.

It will be noticed that the over-all maternal death-rate was 9.4 per cent, and that the death-rate among the infants, including stillbirths and neonatal deaths, was 17.1 per cent. On further analysing the outcome in the groups of cases which comprise the total series several interesting facts emerge.

(a) *Beri-beri complicating normal pregnancy.* In the 119 cases belonging to this group there were 7 maternal deaths (5.9 per cent) and 17 stillbirths and neonatal deaths (an infantile death-rate of 14 per cent). Generally speaking, satisfactory results followed the institution of treatment, cardiac symptoms cleared up, the oedema began to disappear and the patient usually gave birth to a living baby. All of the cases

of maternal death were due to cardiac failure which did not respond to treatment. There were many cases of acute cardiac beri-beri, however, in which the effects of intravenous medication with thiamine were nothing short of dramatic, and recovery resulted in several patients whose condition at first appeared hopeless.

TABLE VI.
Results of Treatment in 371 Cases of Beri-beri.

Clinical condition	Number of cases	Result to mother: Living	Result to mother: Dead	Result to mother: Per cent	Result to child*: Living	Result to child*: Dead† S.B.	Result to child*: Dead† N.D.	Result to child*: Per cent
Beri-beri with normal pregnancy ...	119	112	7	5.9	104	12	5	14.0
Beri-beri with pre-eclampsia I ...	92	89	3	3.3	83	2	10	12.6
Beri-beri with pre-eclampsia II ...	122	115	7	5.7	107	15	8	17.7
Beri-beri with eclampsia	36	22	14	38.8	24	8	6	36.8
Beri-beri with nephritic toxaemia ...	1	—	1	—	1	—	—	—
Beri-beri with hypertensive disease ...	1	1	—	—	1	—	—	—
Totals:	371	339	32	9.4	320	37	29	17.1

* Figures include 15 twin deliveries.
† S.B.—Stillbirth. N.D.—Neonatal death.
Stillbirth figures include 4 infants who died undelivered.

(b) *Beri-beri complicated by Pre-eclampsia, Grade I.* There were 3 maternal deaths, 3.3 per cent, and a mortality-rate for the child of 12.6 per cent in this group of patients. Relatively few of these cases were complicated by cardiac failure, and nearly all of them responded well to the usual treatment for mild pre-eclampsia combined with moderate doses of vitamin B_1.

(c) *Beri-beri complicated by Pre-eclampsia, Grade II.* There were 7 maternal deaths, 5.7 per cent, and 23 infant deaths, 17.7 per cent, under this heading. In one fatal case (Hospital No. 758/40), the patient was a primipara, aged 30, and was admitted complaining of severe oedema and shortness of breath. Examination showed generalized oedema, moist *râles* in the lungs, orthopnoea, dilatation of the heart and other signs of acute cardiac failure. There was anaesthesia of the legs and hands, severe weakness of the calf muscles and absence of the knee jerks. The blood-pressure was 194/124, the urine contained much albumin with granular casts. The pyruvic acid was 3.5 mg. per 100 c.c. of blood. In spite of treatment for cardiac failure, including the intravenous injection of 60 mg. of thiamine, the patient died undelivered 20 hours after admission. On the other hand, some striking recoveries were seen in this group. In one illustrative case (Hospital No. 2561/40) the patient, a 7-para, aged 39, had suffered from generalized oedema for over 6 weeks. The knee jerks were absent and there was definite pulsation over the great vessels. Granular casts and albumin were present in the urine and there was a blood-pressure of 170/100. The pyruvic acid reading was 2.1 mg. Treatment with thiamine was started and a week later the patient was delivered of twins at the 39th week of pregnancy. At the end of 10 days, during which time the patient had received a total of 160 mg. of vitamin B_1, the oedema had almost disappeared and there was a reduction in the body weight of 52 pounds.

(d) *Beri-beri complicated by Eclampsia.* The most severe clinical picture of all was seen in these cases. In this series of 36

patients there were 14 maternal deaths, a mortality-rate of 38.8 per cent, with an infant loss of 36.8 per cent. A peculiar feature of these cases was the frequent incidence of postpartum eclampsia, which was seen in 9 out of the 14 fatal cases, or nearly 65 per cent, the onset of convulsions being delayed in several instances up to 4 or 5 days after delivery. Autopsies were obtained on about half of the fatal cases, and almost invariably revealed signs of acute cardiac failure with other evidences of beri-beri, in addition to severe changes in the liver and kidneys. In a typical case (Hospital No. 2004/40) the patient was a 2-para, aged 24, with pregnancy at term. She was admitted with a history of oedema, numbness and weakness of the lower extremities for about 6 weeks. For 4 days there had been headache and dimness of vision. The knee jerks were absent, and there was wasting and tenderness of the calf muscles, and an appreciable degree of cardiac dilatation. The urine contained albumin with hyaline and granular casts. The blood-pressure was only 122/74, and the pyruvic acid was 1.45 mg. per 100 c.c. of blood. A living child was born 3 hours after admission, but the patient's condition continued to grow worse, and the blood-pressure gradually rose to 190/110. On the 5th day of puerperium she developed obvious cardiac failure, followed after a few hours by a single, typical eclamptic convulsion. Three hours later she died of cardiac failure. At the autopsy there was the usual picture of acute beriberi with resultant cardiac failure—a large, flabby, dilated heart with pulmonary oedema, hydro-pericardium and passive congestion of the liver, spleen and kidneys. In addition, the liver showed multiple areas of haemorrhagic necrosis, and there was cloudy swelling of the kidneys with fatty degeneration of the tubules. The postmortem diagnosis was eclampsia with acute cardiac beri-beri and death from heart failure. In another case (Hospital No. 3026/41), complicated with antepartum eclampsia, and right-sided dilatation of the heart, the patient made a good recovery after the use of 1,020 mg. of thiamine. She had the usual signs of eclampsia and beriberi, including a blood-pyruvic acid reading of 2.05 mg. She gave birth to twins, of whom one lived and the other died during the neonatal period.

(e) *The association of Beri-beri with Nephritic Toxaemia and with Hypertensive Disease* was only seen in 2 cases. One, a severe case of nephritic toxaemia, died, and the other patient recovered. It was not felt that any conclusions could be drawn from so small a series, but it was thought remarkable that, out of a total of 10 cases of nephritic toxaemia and 30 cases of hypertensive disease, only one of each group should develop beri-beri.

For the sake of comparison with the results summarized in Table VI the mortality-rates in the formerly mentioned series of 908 cases of pregnancy toxaemia are shown in Table VII.

When the results shown in this table are considered, they serve to emphasize the fact that the outlook for the patient is considerably less favourable when pregnancy toxaemia is complicated by frank beri-beri. The above table includes all cases of toxaemia, whether or not complicated by beri-beri. If the 252 cases with obvious beri-beri in addition to the signs of toxaemia were eliminated from the table the results would be still more striking. This fact can be best appreciated from the eclampsia figures. In a previous study of eclampsia in Chinese patients by one of the writers[24] a mortality-rate of 12.1 per cent was reported. During the 3 years when beri-beri became so widespread in Hong Kong the eclampsia mortality, as shown in Table VII, rose to 24.1 per cent in the 79 cases observed, in spite of the fact that the methods

of treatment remained substantially the same. The association of beri-beri with eclampsia was noticed in 36 out of the 79 cases. Fourteen of these cases died, giving a mortality-rate of 38.8 per cent for eclampsia complicating beri-beri as against 11.6 per cent for the 43 cases of eclampsia without manifest signs of beri-beri, a figure much more in accord with previous experience.

TABLE VII.

Mortality Rates in 908 Cases of Pregnancy Toxaemia.

Clinical condition	Number of cases	Maternal deaths		Infant deaths*	
		Number	Per cent	S.B. & N.D.	Per cent
Pre-eclampsia, Grade I ...	461	4	0.9	39	8.2
Pre-eclampsia, Grade II ...	328	9	2.7	43	12.4
Eclampsia	79	19	24.1	26	31.7
Nephritic toxaemia	10	1	10.0	3	30.0
Hypertensive disease ...	30	—	—	2	6.6
Totals:	908	33	3.6	113	12.0

* S.B.—Stillbirth, N.D.—Neonatal death.
Stillbirth figures include 4 infants who died undelivered.
There were 34 twin deliveries.

DISCUSSION.

A deficiency of vitamin B_1 may arise from:

(*a*) a deficiency in the diet,
(*b*) a failure of absorption,
(*c*) a deficient storage capacity,
(*d*) a failure of utilization,
(*e*) an increased requirement.

Human beings are unable to synthesize vitamin B_1, nor can they store it in the body tissues to any extent: they are therefore very liable to develop beri-beri in the presence of predisposing factors. Such factors include poverty, with consequent dietary deficiency, pregnancy, lactation and any other circumstance which calls for an increase in the metabolic rate, such as increased physical exertion, hyperthyroidism, febrile disease, etc. There is usually an interval between the time when the patient begins to suffer from a depletion of vitamin B_1 and the appearance of the symptoms of beri-beri. During this interval, which may last for many weeks or months, the patient is symptom free, but exists on an abnormally low thiamine intake. This intervening period might be called the stage of subclinical beri-beri. The appearance of any unusual call on the body reserves, such as increased exertion, pregnancy or an acute illness, might be sufficient to precipitate the patient into a condition of fully developed beri-beri.

In Hong Kong, during the period under review, the train of circumstances could be very clearly traced. Beri-beri has always been endemic in South China, and there is evidence that the condition was recognized by the Chinese[25] as early as 2697 B.C. In Hong Kong the disease had always been present among the lower classes and among those whose diet consisted largely of polished rice. During the years under review the general medical service of the Colony encountered a very marked rise in the incidence of beri-beri and the gravity of the situation was repeatedly emphasized in the Annual Reports of the Director of Medi-

cal Services.[26] In actual fact the total deaths from beri-beri in the Colony rose from 3,189 in 1939 to 7,229 in 1940. As pointed out in these reports, the increase in beri-beri was a real, and not an apparent one, brought about by an unprecedented influx of refugees from war areas with consequent poverty and overcrowding, all factors which helped to render the conditions ideal for the development of beri-beri. A further factor was the extreme unwillingness of the people to eat anything but polished rice, although great efforts were made to popularize the eating of unpolished or "red" rice. The increase in the amount of beri-beri seen among obstetrical patients was, therefore, only the natural reflection of a generally prevailing condition.

In the 371 cases reported in this paper, manifest signs of beri-beri were encountered. There were, however, two additional groups of cases which came into prominence during the same period, and which appeared in some way to have a relation with the beri-beri cases. On the one hand there was a large group of 676 cases with simple oedema uncomplicated by any other signs of beri-beri or of pregnancy toxaemia. It was tempting to place all of these cases in the beri-beri group, but in the absence of complete proof as to the origin of the oedema the authors preferred to place these cases in a separate class. There is little doubt in the minds of the writers, however, that the oedema was of nutritional origin, and that these 676 cases were examples of sub-clinical beri-beri. On the other hand there was a still larger group of 908 patients suffering from pregnancy toxaemia in one form or another. This gives a general toxaemia-rate of 7.82 per cent for the three years 1939, 1940 and 1941, as compared with the much lower rate of 3.45 per cent for the preceding three years 1936, 1937 and 1938. A striking increase in the toxaemia-rate running *pari-passu* with the figures of an unprecedented outbreak of beri-beri would seem to the writers to be more than a mere coincidence.

Perhaps the most interesting feature of the whole series of cases, however, was the fact that 70 per cent of the patients with beri-beri showed co-existing evidence of pregnancy toxaemia. This fact, together with the tendency, just noted, to a parallel increase in the figures for both diseases, would seem to point to the conclusion that the association between nutritional oedema, beri-beri and pregnancy toxaemia is by no means a fortuitous occurrence. The combination of the manifestations of beri-beri (such as oedema, polyneuritis, cardio-vascular symptoms and a high pyruvic acid content of the blood) with the usual evidences of pregnancy toxaemia (such as high blood-pressure, albuminuria, increased uric acid content of the blood and, in some cases, typical eclamptic convulsions) provided a clinical picture at once interesting and complicated. Vitamin B_1 therapy was naturally used in treating patients who showed clear signs of deficiency. In treating these patients it became more and more manifest that an almost uniform improvement resulted in the great majority of all cases of beri-beri and toxaemia, whether simple or combined. It finally became customary to treat all these patients with thiamine, in addition to the usual dietary, eliminative, sedative and other methods of treatment appropriate to the clinical condition. The conviction grew in the minds of the writers that a causal relation exists between a relative or actual deficiency of vitamin B_1 on the one hand, and the occurrence of pregnancy toxaemia on the other. They feel that their view is supported by the following facts:

(*a*) There was an almost parallel increase in the incidence of beri-beri and pregnancy toxaemia in Hong Kong during the years 1939, 1940 and 1941. During these years

the toxaemia-rate rose to 7.82 per cent as compared with 3.45 per cent in the preceding 3 years.

(*b*) There was a greatly increased incidence of twins in both groups of cases (1 in 24.7 for the beri-beri group, and 1 in 26.7 for the toxaemia group as compared with a general incidence of 1 in 105.7 for all deliveries).

(*c*) In 70 per cent of the cases suffering from beri-beri pregnancy toxaemia was present in one of its forms as a complicating factor. In the remaining 30 per cent of cases the blood-pressure was generally higher than that usually seen in beri-beri.

(*d*) There was a phenomenal increase in the incidence of eclampsia during these years, 45.5 per cent of the cases being complicated by frank beri-beri. The eclampsia mortality-rate rose from 12.1 per cent in normal times to 24.1 per cent during the period under review, and in the beri-beri group the mortality was over three times as high as in the uncomplicated group.

(*e*) There was an even greater increase in the incidence of the severe type of pre-eclampsia during the same period.

(*f*) Blood pyruvic acid determinations showed the high levels typical of vitamin B_1 deficiency in a large proportion of the cases of toxaemia.

(*g*) The lost studies of the writers on the quantitative vitamin B_1 content of the blood and urine added further support to the evidence.

(*h*) The therapeutic effect of the administration of vitamin B_1 was often as marked in cases of severe pregnancy toxaemia as in typical cases of beri-beri. In many patients suffering from severe pre-eclampsia it was felt that the onset of convulsions was averted by vigorous treatment with vitamin B_1 in addition to the usual methods adopted in such cases.

Such a view is supported by the findings of various workers whose writings have been quoted earlier in this paper. Nevertheless, some authors have argued that the use of thiamine in pregnancy toxaemia is not only useless but possibly even harmful. This is difficult to understand in view of the established fact that the need for vitamin B_1 is increased about three times during pregnancy and lactation, and that in human beings there is no recognized overdosage of vitamin B_1. In dogs the lethal dose of vitamin B_1 has been stated to be 350 mg. per kilogram. It has been shown that a human being can tolerate a dosage of 500 mg. daily for as long as a month with no adverse signs. This dosage is far in excess of anything likely to be used clinically, and the writers have never noticed any adverse effects from the use of dosages up to 180 mg. per day in severe cases of cardiac beri-beri with complicating toxaemia.

The nature of the relation between vitamin B_1 deficiency and the toxaemias of pregnancy is more difficult to discuss, and at the present time the authors are not prepared to offer an opinion as to whether hypovitaminosis B_1 merely predisposes to the development of pregnancy toxaemia or whether the deficiency is the actual causal factor. They incline towards the latter view, but the proof which they had hoped to produce was destroyed when almost within their grasp. A discussion as to the nature of the origin of oedema is beyond the scope of this paper, but a theory which has appealed to the writers is that vitamin B_1 is essential to the proper functioning and well-being of the endothelium of the blood-vessels as well as to the peripheral nerve fibres. In the event of a deficiency of vitamin B_1, degeneration of the endothelial cells and nerve fibres occurs with the consequent appearance of oedema and evidences of polyneuritis; if the vagus nerve is affected the heart will also show signs of disturbance, and one or more of the well-known clinical forms of beri-beri will result. In the event

of pregnancy occurring an increased strain is imposed on the maternal organism. In an effort to secure the proper nutrition of the foetus the blood-pressure rises and overcomes the barriers imposed by oedema. In this way the manifestations of pre-eclampsia may arise and, in certain cases, eclampsia itself may occur. A recent communication by Rosenbaum and Maltby[27] suggests that eclampsia is likely to occur in patients who have evidence of a primary cerebral dysrhythmia. In 65 per cent of 20 cases with eclampsia they found electro-encephalograms indicative of cerebral dysrhythmia. They suggest that such a condition may be present in patients who develop eclampsia and that an associated toxaemia may act as the trigger mechanism which exaggerates the inherent dysrhythmia to the extent that convulsions appear. In the event of such an hypothesis proving true it would be easy to understand how eclampsia could readily occur in severe cases of beri-beri complicated by pregnancy toxaemia, and it would, to some extent, explain the unduly high incidence of eclampsia in the present series of cases.

Summary and Conclusions.

1. There was a striking increase in the incidence of beri-beri in Hong Kong during the years 1939, 1940 and 1941. This was a true increase and was seen in general medical and surgical cases as well as in obstetrical cases.

2. There was an almost parallel increase in the incidence of pregnancy toxaemia during the same period, especially in cases of eclampsia and of severe pre-eclampsia. This also was a true increase, the toxaemia-rate rising from 3.45 per cent during the preceding 3 years to 7.82 per cent during the 3 years under review.

3. Some correlation between these figures is inescapable, and it was found that, out of 371 cases of beri-beri complicating pregnancy during this period, no fewer than 252 cases were further complicated by pregnancy toxemia.

4. The diagnosis of beri-beri and pregnancy toxaemia was supported by both clinical and laboratory findings. Significantly high readings of the pyruvic acid content of the blood were obtained in the great majority of cases.

5. In cases suffering from toxaemia with complicating manifestations of beri-beri, the prognosis was considerably more grave than in cases of toxaemia without frank signs of beri-beri. This was particularly seen in the eclampsia cases, in which a mortality-rate of 38.8 per cent was found in 36 cases complicated by beri-beri, as opposed to 11.6 per cent in 43 uncomplicated cases.

6. It is suggested that the primary factor responsible for the heavy increase in pregnancy toxaemia during the years under review was vitamin B_1 deficiency. Arguments are advanced in support of the view that a causal relation exists between a deficiency of vitamin B_1 and the occurrence of pregnancy toxaemia.

7. Prophylaxis and/or active treatment by the exhibition of adequate amounts of vitamin B_1, whether in the form of a vitamin-rich diet or as thiamine medication, is suggested as perhaps the most important single measure in dealing with pregnancy toxaemia in any of its forms.

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Appendix.

Criteria for the Classification of the Toxaemias of the Latter Half of Pregnancy.

(1) *Pre-eclampsia, Grade I (Mild).*

The appearance during the latter half of pregnancy and disappearance by the 6th week postpartum of two or more of the following:

(*a*) Systolic blood-pressure of 130 or higher for 2 days or longer.
(*b*) Albuminuria on more than one occasion.
(*c*) Oedema of the legs and ankles which has no other obvious cause.

(2) *Pre-eclampsia, Grade II (Severe).*

The appearance during the latter half of pregnancy and disappearance by the 6th week postpartum of the signs noted above with the addition of one or more of the following:

(*a*) Systolic blood-pressure over 150 for 2 days or longer.
(*b*) Albuminuria with granular casts or albumin in excess of 2 gm. per litre.
(*c*) Excessive oedema.
(*d*) Any of the danger signals of impending eclampsia such as headache, tinnitus, visual disturbance, epigastric pain, vomiting, jaundice, suppression of urine, etc.

(3) *Eclampsia.*

(*a*) *Convulsive type*: The appearance of typical convulsions in a case showing some or all of the signs noted above.
(*b*) *Non-convulsive type*: The development of coma in a patient showing some or all of the signs noted above (particularly jaundice) with postmortem findings typical of eclampsia.

(4) *Nephritic Toxaemia.*

The presence before pregnancy or appearance before the 30th week of pregnancy and/or the persistence for longer than 6 weeks post-partum of 2 or more of the following evidences of renal disease:

(*a*) Hypertension.
(*b*) Oedema.
(*c*) Albuminuria.
(*d*) Albuminuric retinitis.
(*e*) Impaired renal function.
(*f*) Nitrogen retention in the blood.

Renal disease may be classified as:

(*a*) Glomerulo-nephritis.
(*b*) Nephro-sclerosis.
(*c*) Nephrosis.

(5) *Hypertensive Disease.*

(*a*) *Benign or essential hypertension.* A systolic blood-pressure persistently above 130, either present before pregnancy or appearing during pregnancy, and persisting longer than 6 weeks post-partum. There may be slight albuminuria and oedema as term approaches, but the height of the blood-pressure is out of proportion to these signs. The renal function is normal and the retina is normal or may show some narrowing of the vessels.

(*b*) *Malignant hypertension.* Typical changes take place in the retina and later there is impairment of the cardiac and renal functions.

Studies in X-ray Pelvimetry
An Evaluation of Pelvic Radiography, with a Plea for Simplicity

BY

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INTRODUCTION.

THE purpose of the present paper is mainly to report a study on 60 dry pelves in which Nicholson's formula[1] for finding the areas of the pelvic brim and outlet is put to the test. But an attempt has also been made to bring X-ray pelvimetry closer to its true level of value; and technique which corresponds more faithfully with its possibilities is recommended. Certain fundamental observations are set out which, if not new, have been verified experimentally: there is too much uncertainty about these facts, and it is necessary to avoid the confusion that is apparent in writing and in discussion alike.

If we are of the opinion that operative obstetrics has advanced, it must still be admitted that there is no method of predicting with certainty whether a given pelvis will cause serious obstruction to the foetal head or not. If one held the bony pelvis in one's hand for inspection and were able to make direct measurements, a very wise assessment of the adequacy of such a pelvis could be worked out; but with a number of specimens this prognosis is conditional on so many factors that it will be obvious to the critical pupil that there is no absolute means of knowing whether a head will pass through the girdle or not. When this problem is applied to the living subject, there is the added difficulty that the bony pelvis can neither be seen nor readily measured. X-ray pictures of its different aspects will tell something of the bony shape, and the application of certain principles will even give some measurements.

The failure of radiology to solve single-handed the problem of dystocia due to disproportion led to disappointment, and the opinion that only clinical experience based in digital pelvic examination was of value. The latter idea is defeatist, for the clinician of sound experience knows not only his limitations but also his inability to guide members of that large group on which women are dependent for their delivery. In a word, we are still unable to reduce labour to mathematics. Even brilliant clinical ability aided by pelvic radiology falls short of this objective. This notwithstanding, it may well be possible to simplify our radiological requirements for each case sufficiently to give guidance to the average accoucheur. It would be contemptible to deprive him of the help of an accessory method by making it too complicated; as if to imitate Nature, who has put the basic secrets of parturition just beyond the reach of the wisest and most experienced obstetricians.

It may be asked whether anything reliable may be gained from an X-ray study of the obstetric pelvis. It has to be admitted that, in order to answer different questions about a pelvis, several radiographic views may be necessary and that, for the pur-

pose of measurement, various modifications may be required. But for general use it is necessary to devise a method which is both simple and of an accuracy which is clearly known. With this in mind, we must make a decision about the salient features of the pelvis which will not only contribute towards its classification but also give its capacity. Our first object, then, is clear. And as the skiagram increases knowledge regarding the mechanism of labour, so more will inevitably be demanded of it.

PART I.

Nicholson[1] suggested that the four functions of the pelvis which are of value for obstetrics are: the pelvic index and area of the brim, the area of the outlet, and the subpubic angle. It is proposed that two more should be considered, viz., the depth of the pelvic basin and the height of the symphysis pubis. But we wish particularly to avoid complicating the method of X-ray pelvimetry. Therefore, although on academic grounds we believe that the 6 features of the pelvis mentioned above are the ones essential to prognosis, for general purposes all that is required is a knowledge of the areas of the inlet and outlet, and the pelvic brim index. The height of the symphysis pubis can readily be measured with a pelvimeter, and the capacity of the pubic arch assessed by palpation.

As early as the middle of the 18th century Roederer[2] "likened the superior strait to an ellipse" (W. Williams[3]); and in von Stein's[4] classification three pelvic types were designated: round, longitudinal-elliptical, and transversely-elliptical. But it was Nicholson[1] who made use of the fact that the shape of the pelvic brim closely resembles an ellipse of which the axes are the conjugate and greatest transverse diameters. Similarly, at the outlet the area of the plane of least pelvic diameters can be calculated from two axes, viz., the interspinous and pubosacral diameters. This formula was adopted in studying their series of pelves by both Nicholson[1] and by Ince and Young.[5] So significant is Nicholson's suggestion that it was decided to test the accuracy of his formula on skeletal material.

EXPERIMENTAL.

Dioptographic tracings were made of the brim of the pelvis and outlet, and areas were obtained both by calculation and by means of a planimeter. The latter area would be the true area, and in this study a maximal accuracy to the nearest $\frac{1}{10}$th of a square centimetre was attained.

The area of the pelvic brim. Sixty female pelves were used, 52 of which were from the Bantu collection described elsewhere and 8 of mixed "coloured" race. In each case the area calculated by Nicholson's formula was smaller than the true or planimeter area. The percentage error ranged from −1.5 per cent to −20.3 per cent. As the greater figure occurred in an example of spondylolisthesis where the promontory of the sacrum projected unduly into the plane of the brim, thus interfering with its shape as an ellipse, it may be stated that the next greatest error amounted to −13.1 per cent. The average error was −8.5 per cent, but 19 out of 60 observations showed an error of over 10 per cent.

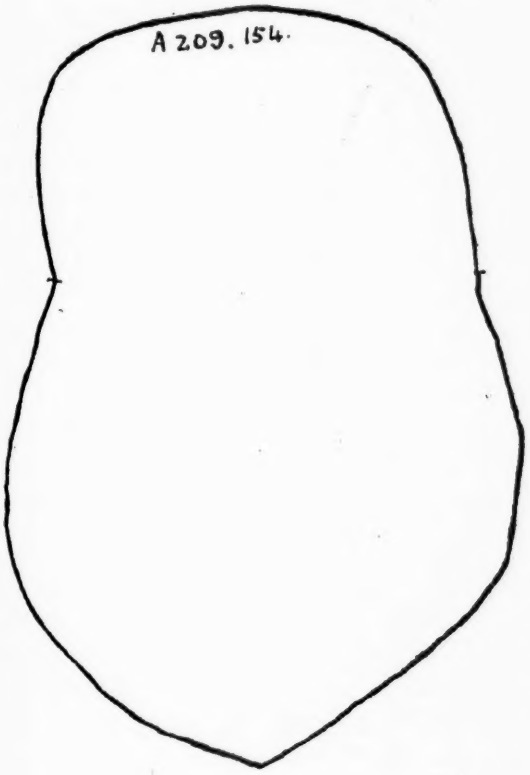
The main source of this large error was found to be the promontory. Thus, if the sweep of the brim outline was continued with a disregard for the sacral promontory, a complete flattened circle was obtained. A large sacral promontory which projects far across the pelvic basin unjustifiably shortens the conjugata vera and lowers the pelvic index. Reliance on the basic value of this diameter, which still persists in obstetrics, can make a pelvis appear small, whereas the area of the pelvic brim dis-

counting this encroachment of the promontory, may be larger by as much as 10.0 sq. cm. or more. Even if the conjugate is shortened sufficiently to obstruct passage of the foetal head, the transverse diameter of the brim may be absolutely increased and allow easy engagement of the head. The pelvic cavity below this plane would then, all things being equal, accommodate the head with ease. It may be demonstrated by anyone too, that a skiagram of the pelvis with the brim horizontal or nearly so, does not show the anterior border of the promontory. A piece of lead wire placed along this edge in a specimen of the pelvis lies well forward of any shadow of bone that can be identified on the film. It is necessary that both these facts should be recognized, and the matter may be stated thus: that the sacral promontory should be disregarded for the reasons mentioned, and because of the fact that in the mechanism of engagement of the foetal head it is not necessarily an obstruction; and that in any case the whole promontory is not outlined in the so-called A.P. X-ray views.

The dioptographic tracings were, therefore, enlarged by completing the posterior portion of the pelvic brim curve and so removing the encroachment of the promontory (Fig. 3). This is very readily done on the radiograph where a portion only of the projecting bone is seen. The new conjugate diameter would then be longer, and the calculated area would be correspondingly greater than before. The planimeter area would also be increased, most frequently by about 5.0 sq. cm. but occasionally by more than 10.0 sq. cm. With this modification it was found that the formula and planimeter areas corresponded closely. In 60 pelves the average area of this complete ellipse was 116.6 sq. cm. by the planimeter and 116.3 sq. cm. by calculation. The percentage error was both positive and negative, and varied from −4.9 to +9.6. In 11 cases the error was above 3.5 per cent, and in only 2 of these above 5.0 per cent (+5.2 per cent and +9.6 per cent). Fig. 4 shows a comparison of the error obtained by Nicholson's formula and the modification here suggested. The blackened blocks are very much smaller than the large plain ones, both representing the mean error of calculation for different ranges of area obtained by the planimeter. The calculation of the modified area of the brim can be said to be well within an error limit of 5.0 per cent.

Even so high an error as 5 per cent may be avoided. It must be remembered that the shape of the brim is considered as an ellipse, and where this shape departs grossly from this flattened circle there is a liability to error. In studying the brim tracings the observation was made that either asymmetry or an "angular" suprapubic angle led to the highest error. In 8 of the 11 areas in which the error was above 3.5 per cent the two oblique diameters of the brim differed by 0.5 cm. or more, the range being 0.5 cm. to 0.9 cm. Of the other 3 pelvic brims, 2 had equal oblique diameters, and 1 showed a difference of 0.2 cm.; in 2 of these there was marked asymmetry of the fore pelvis, and in one where the error was +9.6 per cent the brim was beak-shaped. Now it will be obvious that where the anterior half of the brim is nearly triangular, the actual area will be less than that of an ellipse with axes equal to those of the beak-shaped brim.

An attempt was made to reduce these 11 brim tracings to two half-ellipses, or to take the posterior portion of the brim as a half ellipse and the anterior portion as a triangle. But the sum of the calculated areas of these portions did not give an accurate final result. It is suggested, therefore, that where there is asymmetry of a brim as seen on the radiograph, or an undue narrowing to an angular shape at the symphysis



I.I.S.	6.3 cm.
A.P.O.	11.1 cm.
Max. T.O.	7.8 cm.
P.	68.1 sq. cm.
F.	54.9 sq. cm.
Ell.	68.0 sq. cm.

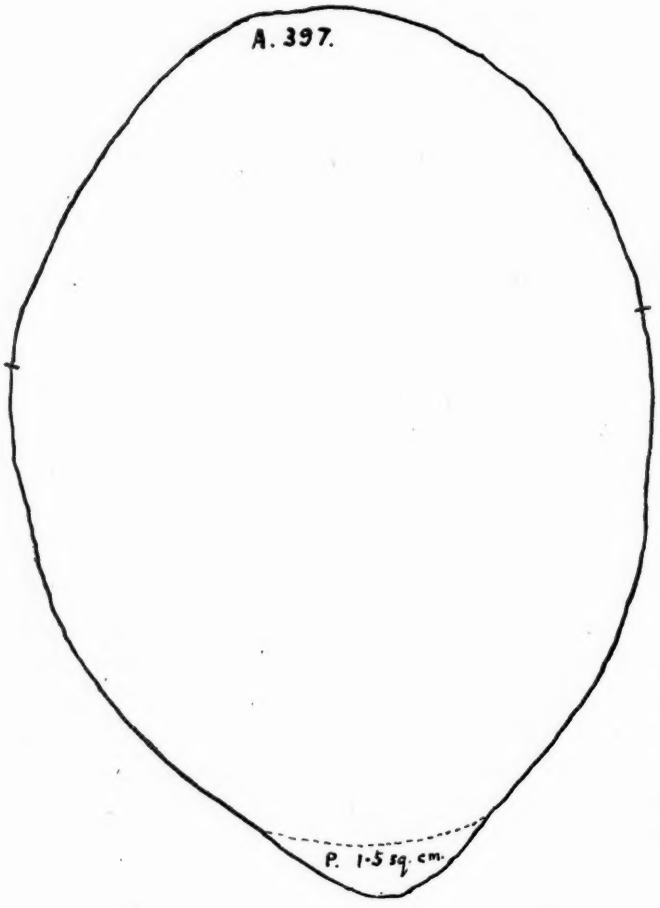
Error 13.2 sq. cm., or − 19.4 per cent.

Ellipse area = true area.

FIG. 1.

Dioptographic tracing of plane of least pelvic diameter (A.209). The exaggerated size of the ischial spines reduces the interspinous diameter too much to allow it to operate as an axis in the calculation of this area as an ellipse.

I.I.S.	=	inter-ischial spine diameter.
A.P.O.	=	pubo-sacral diameter.
Max. T.O.	=	maximal transverse diameter of tracing.
P.	=	planimeter area.
F.	=	area calculated from I.I.S. and A.P.O. (Nicholson).
Ell.	=	area calculated from Max. T.O. and A.P.O. (ellipse).



I.I.S.	9.6 cm.
A.P.O.	13.0 cm.
Max. T.O.	9.6 cm.
P.	94.1 sq. cm.
F.	98.1 sq. cm.
Ell.	98.1 sq. cm.

Error 4.0 sq. cm. or 4.25 per cent.
Ellipse area = F. area.

FIG. 2.

Dioptographic tracing of plane of least pelvic diameter, showing the effect of an angular anterior pole on the calculated area (A.397).

*Note on A.*397.—This outlet shape is very close to the perfect ellipse. The discrepancy, however slight, in the result of the formula is probably due to the angle which the outline gives when the under-surface of the symphysis is approached. This angular shape at that pole of the ellipse is unavoidable. If this " angle " is eliminated, it will be observed that the formula gives a result very close to the true area given by the planimeter.

With A.P.O. 12.3, F. = 92.77 sq. cm.
For this area P. = (94.1 − 1.5) sq. cm.
= 92.60 sq. cm.

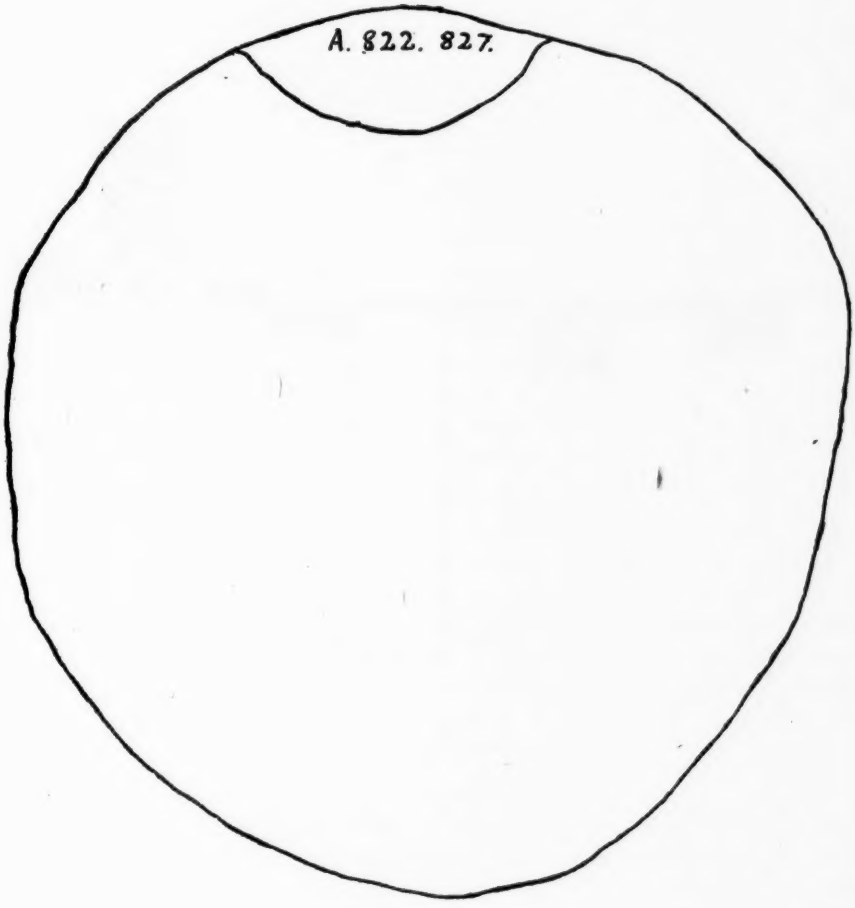


FIG. 3.

Dioptographic tracing of pelvic brim (A.822. 827).

Area of plane of brim by planimeter = 123.2 sq. cm.

Area of plane of brim by calculation = 111.9 sq. cm.

Error = − 9.2 per cent.

Planimeter area of plane of brim eliminating promontory = 128.1 sq. cm.

Calculated area of plane of brim eliminating promontory = 128.6 sq. cm.

Error = + 0.4 per cent.

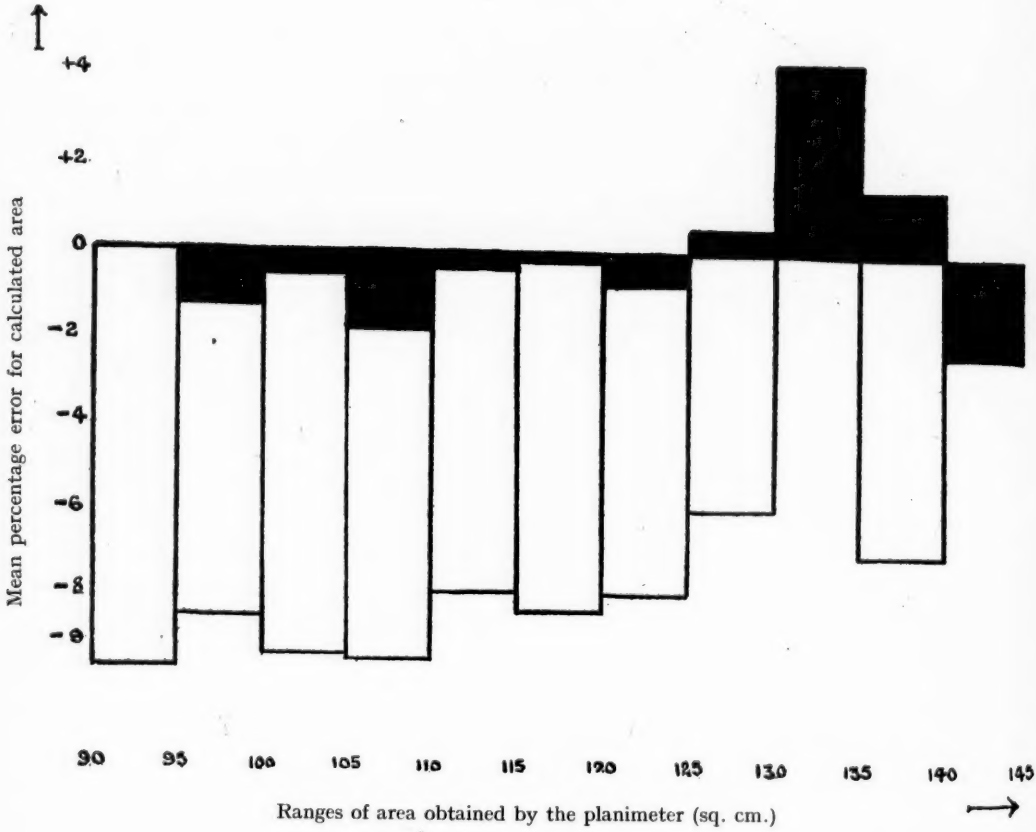


FIG. 4.

Area of the pelvic brim—a comparison of the accuracy of two methods of calculation.

The open blocks represent the mean error for areas obtained by Nicholson's formula, the solid blocks the smaller error for areas obtained by modification suggested in this paper.

Ranges of 5 sq. cm. of planimeter areas have been taken, and the two mean percentage errors found for the corresponding areas obtained on calculation by the two methods respectively.

pubis, our method of calculation should be suspect. In these cases the area should be determined by making a tracing frrom the X-ray film and applying to it either graph paper or a planimeter. Use of the planimeter is much more rapid and accurate, but if the instrument is not available there should be no difficulty about the use of squared paper.

It was found that the shape of a brim might be asymmetrical and yet give an accurate area by calculation. Careful examination in such a case might show it to resemble an ellipse lying obliquely, or it may be a matter of luck that the axes were of a length to give an accurate result. In view of these findings, it may be stated that only with grossly abnormal brim shapes is there the likelihood of an error exceeding 5.0 per cent. This figure of 5 per cent means, on the average, an area of about 5.0 sq. cm. which is too small to influence our present knowledge of the effects of the pelvis on labour. When accuracy for academic purposes is required, all asymmetrical brims should have the area determined directly, not by calculation; and this procedure should be adopted by all other workers when in doubt.

The area of the plane of the outlet. This success with the brim areas was not attained when the outlet was studied. Dioptographic tracings were made after numerous methods for this purpose had been tried. In some cases the outlet plane (plane of least pelvic diameters) could be seen entirely from above only, in others mainly from below. It was found that inaccuracy resulted from viewing an outlet partly from above and partly from below. Stiffened white cord was used in a suitable length and fixed with small pieces of plasticine to run from the lower end of the sacrum in a curve towards the ischial spines and thence to the lower end of the symphysis pubis. From the ischial spines forward the cord would hug the lateral wall of the pelvis at the correct level. Viewed from below only, the outlet could in most cases be traced with sufficient accuracy, even though the cord disappeared for a part of the distance anterolaterally.

The ellipses obtained at the outlet were much more perfect than those at the level of the brim. Nevertheless, the axes of the brim were true, being the longest diameters of the brim. At the outlet the axes used were the pubosacral and interspinous diameters, the latter of which is not a true axis, being posterior to the transverse axis which is usually longer than the interspinous diameter. It will be understood, therefore, that, if the interspinous diameter lies close to the sacrum and the ischial spines are large and project unduly towards the midline, this diameter will be considerably shorter than the true transverse axis of our outlet ellipse. The result would be a reduction of the calculated area relative to the true area. This feature may be counteracted by a narrowing of the anterior portion of the ellipse which may tend towards angularity; and for this reason the calculated area is often more accurate than one would expect.

Twenty pelves were studied: the true area was obtained with a planimeter, an area of the ellipse calculated with pubosacral and interspinous diameters as axes, and a third area calculated with pubosacral and widest transverse diameters as axes. Included among the 20 pelves there were 11 specimens with an outlet area below 88.8 $\pm$3.04 sq. cm., which was the mean outlet area by calculation found for a series of 65 Bantu pelves, and 9 specimens above this mean. In order to test Nicholson's formula to the full, some pronounced contractions of the outlet were selected for the experiment. The range of planimeter areas for the group of 20 specimens was 68.1 sq. cm. to 119.6 sq. cm.

Ten areas calculated by Nicholson's formula were less than the planimeter area, and 10 were greater. Twelve calculated areas showed an error of less than 4 per cent, 5 an error of less than 7 per cent, and 3 an error of more than 10 per cent. The error in the last 3 areas was −11.3, −11.4, and −19.4 per cent respectively. A discrepancy of this size is serious and calls for consideration. The planimeter areas for these 3 outlets were respectively 100.9, 72.0 and 68.1 sq. cm.; and the corresponding areas calculated from the pubosacral and widest transverse diameters were 103.9, 72.3, and 68.0 sq. cm., showing a very close correspondence.

In the majority of outlet tracings the interischial spine diameter was less than the maximal transverse diameter which lay anterior to the former. The reason for the near approach of the calculated to the true area is to be found in the fact that the anterior portion of the tracing tends to be angular, and not rounded as in an ellipse (see Fig. 2). Therefore, what is lost in the reduced length of the interspinous diameter is gained in the virtually increased length of the pubosacral diameter. If, then, inspection of the A.P. film shows large projecting ischial spines, it will suggest that the calculated area of the outlet may be smaller than the true area. But an impression of the forepelvis must be got from the film: if there is marked narrowing or angularity, this feature will counteract the effect of the unduly shortened transverse diameter in giving a negative error for the outlet area. There are very few exceptions to the general observation that the forepelvis has the same shape at the level of the outlet as at the brim. Another guide, though not so constant, is the association of a narrow pubic arch with a narrow forepelvis at the outlet.

To summarize, one cannot depend on an accuracy within the limit of a 10 per cent error in calculating the area of the outlet. It is thought that greater errors can certainly be avoided by paying attention to the encroachment of the ischial spines on outlet space, and correlating this with the width of the forepelvis. It may be stated that several modifications were devised to overcome the possible error, but no satisfactory solution was found.

The diameters representing axes of the ellipse. Having shown that by calculation the error limit for the area of the inlet is well within 5 per cent, and for the area of the outlet within 10 per cent, the measurements to be derived from the X-ray film are four in number. The conjugate and transverse diameters at the brim are measured and corrected according to their known height above the film: from them both the area and the brim index are calculated. The derivation of the two outlet axes was more difficult, and they must be considered in some detail.

1. *The interischial spine distance.* The intention was to obtain this diameter from the A.P. film, thus avoiding a second exposure. The difficulty is to find the height of the ischial spines above the table or film.

Thoms'[6] method with a lateral view is favoured by many in the United States. The two spines appear on the lateral film at different levels and of different sizes because they are not equi-distant from the film. Thoms then gets the vertical height of the diameter by making it pass horizontally midway between the two spine levels, and measuring on a scale placed in the midline by the natal cleft. It can easily be shown that the point midway between the spines does not lie on the level of this interspinous diameter, and the method cannot be accepted because the error may sometimes be appreciable.

Paul Cave's[7] and Nicholson's[8] methods are mathematically sound, but require several exposures and more calculation

than in our method. In some cases Cave's vertical shift does not give accurate results, and the reason may be found in the fact that small differences of length resulting from the shift are particularly unreliable unless the shadows are not only very clear, but equally clear. In experimental work on Cave's method we have found that the ischial spine height is level with the table in cases in which it was known to be in the region of 3.0 cm. above this level. While it was thought that this vertical shift method would be very useful to have recourse to when great accuracy was desired, our observations have led to disappointment in the possibilities of this technique.

It occurred to us that the ischial spines might be at a fairly constant height above a table supporting the pelvis placed so that the brim is horizontal. Measurements were made on 60 dry pelves, and this ischial spine height when the inlet is horizontal was found to be remarkaby constant. For the 60 observations the range was 1.7 cm. to 3.7 cm. (only 3 were under 2.0 cm.), with a mean of 2.71 ± 0.13 cm., and standard deviation 0.52 cm.

In the method of this paper the focus-film distance is 100 cm., and the film lies 7.0 cm. below the table surface. Thus the ischial spines would be 7.91 cm. above the film on the average. In our calculations this figure has been made 10.0 cm., which means that the film interspinous diameter must be multiplied by (90 ÷ 100) for correction. If one errs by 1 centimetre in the height of the spines—and this is shown to be the maximal error possible—there will be a 1 per cent error in this diameter of which the length is of the order of 10.0 cm. Therefore, our theoretical error here is only of the order of 1.0 mm.

Finally, with a horizontal brim the ischial spines are invariably visible on a good film, not being overshadowed as in some positions.

2. *The pubosacral diameter.* Even though it was discovered that the interspinous distance could be measured on the A.P. film, it was at first thought that a lateral view would be required for the determination of the pubosacral diameter. It was found, however, that the anterior extremity of this line on the film was indefinite. Experiments were carried out by placing opaque markers on the under surface of the symphysis to serve as a guide in measuring the required diameter. While at best the anterior point selected without a guide was arbitrary, an error of 1 centimetre and more was found to be frequent. In fact, the situation of the true point was so unexpected that, unless observation is supported by practice with guiding markers, a mistake is probable in most cases. It was concluded, therefore, that X-ray measurement of the pubosacral diameter was of no value. Direct measurement with callipers seemed to offer greater accuracy, and would avoid the necessity of a lateral view film.

Clinical measurement is possible only from the posterior surface of the sacrum, though the under surface of the symphysis is easily palpated. It is usual to subtract 1 centimetre from the length obtained to get the true pubosacral diameter. This matter was investigated by measuring 60 dry female Bantu pelves, and the difference between these two diameters—one from the posterior surface of the last piece of the sacrum and the other from its anterior surface—was found to have a range of 0.5 to 1.5 cm. The mean figure for the 60 specimens was 0.92 ± 0.5 cm. with a standard deviation of 0.21 cm.

For practical purposes, then, 1 centimetre may be subtracted from the clinical measurement to give the true pubosacral diameter. The roof of the sacral canal is usually felt without difficulty, and the measurement is taken from the depression

below it to the posterior aspect of the under surface of the symphysis pubis.

It is unfortunate that this important diameter cannot be obtained with any precision radiographically. Nicholson's method is probably the only one which affords any approach to accuracy. While his technique for finding the length in question is theoretically superb, the capricious behaviour of X-ray shadows frequently defeats one here as in so many other instances. Experiments were performed to discover whether the anterior or posterior surface of S5 was seen on the film, when the patient sat forward as in the Chassard and Lapine pubic arch method.[9] The findings became significant only when experiment was transferred to patients. The lower sacrum frequently curves inwards so sharply that some part of it above its tip throws the outermost shadow. In effect the tip of the sacrum is overshadowed by some part of it higher up; and unless the film is of unusual quality, identification of the requisite shadow will be impossible. It is impossible to state precisely what error occurs here, as the curvature of the sacrum is variable; but it is unlikely that radiological measurement is superior to direct clinical determination of this diameter.

PART II.

Before describing the radiological method of pelvimetry recommended, certain fundamentals must be established. Experiments were performed to determine the surface markings of value, and the position of the patient when the brim plane is horizontal. These observations are described in the following section.

Observations.

Spine of L5. Our radiological experiments have shown that when the superior strait is horizontal a prolongation of the conjugata vera runs through the spine of the last lumbar vertebra. This means that the inclination of the pelvis which now is zero can be measured from the 5th lumbar spine, or that the promontory is at the same level as the 5th spine. In the erect posture, however, the conjugata vera produced passes between the spines of L2 and L3, though this will vary according to the pelvic inclination in the subject concerned.

The tip of the 5th lumbar spine, therefore, is at the same level as, or slightly below, the sacral promontory. It is widely recognized that in the majority of cases the promontory lies above the level of the brim as determined by the iliopectineal lines. It is, therefore, more correct to use the 5th lumbar spine than, as frequently suggested, the 4th for the posterior point. According to the method here suggested, the encroachment of the promontory on to the plane of the brim is disregarded in finding the area and brim index. Hence the actual level of the promontory is a matter of indifference. But it is submitted that the 5th lumbar spine is as near to the level of the brim as any vertebral point that can be found; and where there is a slight difference, the error will be so small as to be negligible for practical purposes.

There is some danger of error in finding the surface marking for the 5th lumbar vertebra. This error is unlikely to be more than 2.0 cm. The probability is that a spine higher than the 5th, rather than a point lower, may be chosen. In the first place bony projections on the posterior aspect of the sacrum are not so prominent as the lumbar spines; and in the second, difficulty will be found with a satisfactory semi-recumbent position in getting points well below the 5th spine to the same horizontal level as the symphysis. Our experiments have shown that in the few cases in which

inaccuracy occurs the result for the length of the conjugata vera is only a few millimetres. Some experimental results will now be given because there is confusion on this problem, as in the statement quoted from Jacobs.[10] Even Thoms[11] in "The Obstetric Pelvis" fails to state the position correctly: if the point used for the last spine is 2 cm. higher than the spine itself, the brim plane cannot be said to be 2 cm. lower than it is thought to be. The conjugate in this case is oblique to the horizontal, with the last lumbar spine situated 2 cm. lower than the symphysis.

Geometrical drawings show that with a film-focus distance of 100 cm., if the marker on the patient's back were to be placed 2 cm. above the correct point (last lumbar spine), the error in the final result for the conjugate is on the average almost exactly −2 mm. But if the marker were placed 2 cm. lower than the correct point, there would be no error in the final result. (In the second case the shadow is distorted with loss of length due to obliquity of the conjugate, but the distance between object and target is less than before. This compensates for the loss in length due to obliquity.)

To apply these principles in practice a dry pelvis was taken and a wire fixed in the position of the true conjugate. This wire was measured because the conjugate itself is unreliable for the purpose. It will be obvious that we bring our supposed lumbar 5 point to the same level as the symphysis in practice. Therefore the height of the symphysis gives the object-film height.

Testing of Surface Anatomy Errors in X-ray Views of a Parallel Brim.

(I) Brim horizontal: height above film 18.5 cm.
Length of wire on film = 14.5 cm.
∴ Length of wire = 11.82 cm.

(II) Brim oblique, with symphysis higher. Symphysis height above film 21.8 cm.
Height difference between symphysis and L_5 spine: more than 4.0 cm.
Length of wire on film = 14.0 cm.
∴ Length of wire = 10.95 cm.
Error − 0.87 cm.

(III) Brim oblique with symphysis lower. Symphysis height above film 15.0 cm.
Height difference between symphysis an L_5 spine: more than 6.0 cm.
Length of wire on film = 13.2 cm.
∴ Length of wire = 11.22 cm.
Error − 0.60 cm.
Length of wire = 11.9 cm.

One may accordingly conclude as follows:

With posterior point 2 cm. too high,
error = − 2.0 mm.
With posterior point 4 to 5 cm. too high,
error = − 8.7 mm.
With posterior point 2 cm. too low,
error = 0
With posterior point 6 to 7 cm. too low,
error = − 6.0 mm.

Semi-recumbent position. Great difficulty was encountered in placing the patient in such a position as to obtain a horizontal brim. Experiments were conducted on students and patients to solve the difficulty. As pointed out above, the posterior point is frequently lower than the anterior when the semi-recumbent position is such that the normal ray strikes the brim without passing through the upper abdomen or thorax. If one arranges an effective Walcher position with the subject's lower extremities hanging well over the edge of the table, the pelvis is tilted forward so as to bring the brim horizontal with the woman lying well back. But the Walcher position cannot be used on a standard table. It was found that, if the subject arched her back so as to give a moderate lumbar lordosis, our point was gained: the symphysis was depressed, the 5th lumbar spine raised, and when these two were in the same horizontal plane the patient was still lying sufficiently far back to allow the incident ray to miss the upper

abdomen in women during the first half of pregnancy. It is important to realize that in whatever position the patient is placed, an incident ray at right angles to the brim has to traverse the same amount of tissue. Nothing is to be gained by having the brim in a plane inclined to the horizontal and arranging the tube at a right angle to this plane.

Radiographic Technique.

Equipment: Standard table. Adjustable back-rest that can be bolted to table. Foot-support that can be bolted to table. Centimetre rule and callipers. Dividers or sliding compass for measuring on films. Standard equipment for exposing and developing films.

Exposure: An exposure of 3½ to 4 seconds during the first half of pregnancy, and 4 to 6 seconds for cases in the last 2 months of pregnancy.

Setting: During early pregnancy we have used a kilovoltage of 75 K.V.P. and a current of 80 M.A., and as gestation advances this is raised to 80 or 84 K.V.P. with current 80 M.A.

Method.

The A.P. view is the one on which we rely for all our information; but, if the subpubic angle is considered narrow, a second film is exposed as in the Chassard and Lapine[9] method.

(*a*) The brim must be brought into a horizontal plane. A small strip of adhesive tape is placed over the spine of the last lumbar vertebra, and the patient made to sit back against the back-rest at an angle of over 45 degrees. In order to get the posterior point and the upper edge of the symphysis pubis in the same horizontal plane, the patient has usually to arch her back considerably, only head and shoulders being in contact with the rest. The knees are extended, and the feet pushed against the foot-support. The height of the adhesive strip from the table is measured with the limbs of the callipers crossed, and checked against the height of the symphysis. The lordosis is then regulated until the two heights are equal, the patient instructed to keep still, and the film exposed. A Potter-Bucky diaphragm is used. The height obtained is read against the centimetre rule. To this is added the height of the table surface above the film and thus we have the object-film distance.

The focus-film distance used is 100 cm., but if the apparatus used does not give clear films in late pregnancy, a distance of 75 cm. will give better results. The 100 cm. distance affords simplicity in calculation. The target is centred over what is estimated to be the mid-point of the brim plane (about 6 cm. posterior to the symphysis), a plumb-bob being useful for the purpose.

From this film the interspinous and brim diameters are derived, and the shape of the brim studied.

(*b*) Excellent radiographs of the pubic arch are obtained by sitting the patient at one end of the table directly on a casette covered by a Lysholm grid. The legs, well separated, come over the table edge with the feet supported on a stool, and the trunk is bent forward as low as possible. Personal trial of this position will show that the pubic arch lies against and parallel to the grid. Any target height may be used. We use 100 cm. because we know the approximate error, which in practice is negligible. If it is wished to reduce the relative over-exposure of the lower portion of the sacrum, shading may be done with an opaque mask.

From this film are obtained the height of the symphysis, the depth of the pelvic basin, the intertuberous diameter, and the subpubic angle.

Correction of film measurements. The principle involved is geometrical, similar triangles having certain sides and bases proportional. If the object-film distance is 18 cm. the distance from target to object

is (100–18) or 82 cm. The quotient of the sides of the triangle is, therefore, 82/100 or 0.82, which is the factor by which the film diameter has to be multiplied to find the true diameter.

It has been shown that ischial spine apices are always 3 cm. from the table. We use a table of which the surface is 7 cm. above the film. Thus the spines are 10 cm. from the film, or 90 cm. from the target. In this way the interspinous distance of the film is always multiplied by 0.90. If the table-film distance happens to be 6 cm., the spine-film distance would be 9 cm., and the factor necessary for correction would always be 0.91.

This correction of film measurements is unavoidable. However, with a target-film distance of 100 cm. the calculation has been reduced to its simplest possible form. No correction is required for the pubic arch measurements suggested. The arch is virtually in contact with the film, and for this reason both film and true proportions are very nearly equal.

As it is parallel to the film, the subpubic angle will be unchanged. The symphysis error is about 1 mm. and so is the depth of the pelvic basin if measured in the anterior midline to the top of the symphysis. The anatomical depth is measured from the lowest part of the ischial tuberosity to the brim as a tangent to the anterior curve of the acetebulum, and the error may be up to 3 mm. increase in length. The intertuberous diameter is somewhat arbitrary even on skeletal material, and on the film must be measured a few millimetres above the lowest points of the tuberosities. The technical error will make the film measurement too long by not more than 5 millimetres.

In calculating the area of the planes of brim and outlet, the formula for an ellipse is used, i.e. area $= \pi$ a b (where the axes measure 2a and 2b). In practice one would multiply the product of the two diameters by 11/14.

The brim index is given as a percentage of the antero-posterior diameter divided by the transverse, but this will be discussed later.

Discussion of Results.

1. Experiment with dry pelves has shown that the interspinous distance obtained by this method is extremely accurate. The pubic arch measurements have an accuracy which is adequate for practical purposes, and there is no likelihood of significant errors, nor have we used any clinical method which gives comparable results. As stated above, the pubo-sacral diameter can be measured clinically with the same accuracy as on a radiograph. Pelvimeters do not usually measure in millimetres, and it is best to measure with a pair of callipers and get the distance on a centimetre rule. It has been found convenient to reduce the curve of the limb of the callipers that makes contact with the symphysis. The patient lies in the left lateral position with the right thigh abducted. The roof of the sacral canal is palpated and the measurement is made from the depression below it to the posterior aspect of the under-surface of the symphysis pubis.

Working in conjunction with a colleague, it was found that we varied by a few millimetres in measuring the pubo-sacral diameter. Without due care, an error of a centimetre may occur in some cases. The important features are finding the hiatus sacralis, and the co-operation of the patient.

2. The brim measurements of patients were tested by using Cave's method[7] with a vertical tube shift, and exposing two films. The results obtained showed a close correspondence for the two methods, but the object film (OF) distances did not correspond. The transverse of the brim was

the diameter chosen for comparison, because its extremities on the film are constant. The OF distance in the case of pregnant women disagreed with the measured height of the superior strait by over 4 cm. in a few cases, but always by about 2 cm. This led to keen disappointment, until attention was directed to the ischial spine level and we found that by Cave's formula the ischial spines must frequently be at table level. Experiments were then performed on dry pelves where the measurements are accurately known. Tube-film distances of 65, 100, and 150 cm. were used, and the three possible combinations were worked out. The OF distances varied in the three calculations based on the interspinous distance, one result for the spine-table distance being 1.13 cm. when, in fact, it was 2.5 cm. This finding demonstrates the weakness of Cave's method, for whatever purpose it may be used: the differences in object length (diameter) are very small; and apart even from errors in measuring, the definition of shadows on different films may vary sufficiently to give false differences.

The transverse diameter of the brim proved a much better standard for experiment, for in all three calculations both its length and its OF distance showed differences of not more than a small fraction of a millimetre. Both in the case of skeletal material and patients there were two discrepancies which were constant: the OF distance was always less on calculation (Cave) than on direct measurement, and my corrected figure for the diameter was always less than the one obtained from the Cave formula. The following extract from my notes explains the situation. "Pelvis A.445,519; transverse 10.76 cm. (Cave); and 10.54 cm. (Heyns). When measured on the pelvis the transverse of the brim is well over 11.0 cm., however small the diameter is made. The discrepancy in the OF value must be due to the showing on the film of a circumference which lies deeper than the brim, i.e. somewhere about the level of the plane of the cavity. This would explain (1) why OF is nearly 2 cm. shorter than the true value, and (2) why the transverse is shorter than it should be."

On the clear, perfectly exposed films of skeletal material one can see, at the widest part of the ilium in superior relation to the ischial spines, a narrow white strip of compact bone separating the brim outline from the cancellous bone detail of the iliac fossa. In superior films the lateral border of this strip, which is only a few millimetres wide, can sometimes be traced as the continuation backwards of the ilio-pectineal line. The truth of this was confirmed by finding that the correct X-ray measurement as well as the OF value corresponded very closely with these distances on the dry pelvis.

Examination of the iliac portion of the brim in a funnel pelvis will show that a projection of the brim is likely to be overshadowed by the massive bone lying around it, particularly the great depth of bone lying on its medial side. This medial bony incline is, in fact, represented on the film by the dense white line. In effect, therefore, the bone representing the brim—whether this be the iliopectineal line or a line medial to it on or about the brim level—lies in the substance or shadow of a wide shelf of bone; and, as there is no particular density or prominence about this line, it would be unreasonable to expect it to show up on the X-ray film. In the majority of pelves there is an inward slope of this portion of the ilium towards the ischial spine tips, and an inspection would make it clear why the curve on the film represents the shadow of a pelvic level much deeper than that of the superior strait. Two points must be noted: firstly, the above observations apply to the majority of pelves because there is in them a convergence of the lateral

walls in descending from the superior strait plane; and secondly even perfect exposures do not from necessity show the iliopectineal line in the form of the lateral margin of the dense white strip mentioned above, because this margin is variable. We discovered early that the Roentgenogram never gave the anatomical iliopectineal line as a marking, and that what the film showed as the innermost margin of the iliac portion of the true pelvis was in fact medial to a wire running along the iliopectineal line itself. But we never suspected that this innermost margin of the film represented bone lying near the plane of the cavity of the pelvis.

3. In view of the above observations, it became necessary to investigate the effect on measurements of under-exposure of films and possible distortion from scattering of rays. The changes found were of the order of a fraction of a millimetre and are, therefore, of no practical significance. Even though the experiments could not be performed with mathematical precision, and measurement on films in fractions of millimetres is unreliable, a few experimental results will, nevertheless, be tabulated here, because they are believed to be relevant to the problem.

In the poorly exposed films it was quite impossible to see the white strip, and the longest diameters obtainable were those shown in the first column of Experiment I table.

EXPERIMENT I.

Under Exposure of Films in Case of Bony Pelvis (A.445,519).

	Transverse of brim (cm.)		Inter-ischial spine distance (cm.)	
Focus-film distance (cm.)	Under-exposed	Fully exposed	Under-exposed	Fully exposed
150	11.74	11.80	10.60	10.60
100	12.33	12.40	10.93	11.00
65	13.40	13.50	11.53±	11.55
65 (minimum exposure)	13.38		11.53	

We submit, therefore, that the iliopectineal line or brim of the true pelvis cannot be shown on a Roentgenogram. When radiographing skeletal material good definition is obtained, and the lateral margin of the well-defined white strip on the body of the ilium is a near approach to the anatomical brim of the lesser pelvis. This white strip does not show up in the films obtained from patients, and it will be shown how a superimposed foetus obliterates this shadow. It is submitted, further, that the iliac portion of the radiographic brim is on the average a shadow of the bone approximately at the level of the lower margin of the obturator internus muscle arising from the body of the ischium. These findings were unchanged when stereoscopic examination was done.

A foetus was superimposed on a dry pelvis to test the effect of distortion on measurements. A difference could not be detected. If, however, we take the transverse of the greater curve encompassing the white strip, there is a marked difference due to the fact that the foetal head overshadows one side of the curve (Experiment II). On this side the white strip disappears as entirely as in the under-exposures.

A block of paraffin wax was superimposed on the same pelvis for scattering effects and exposures made at 100 cm. With a full exposure the transverse was 12.35 cm., and with an under-exposure 12.30 cm.

EXPERIMENT II.

Greater Circumference of Inlet on Films (A.445,519).

Focus-film distance (cm.)	Transverse of brim (cm.)	
	Plain pelvis	Foetus superimposed on pelvis
150	12.40	12.10
100	13.10	12.63
65	14.10	13.70

For the above experiments the object photographed and measured is indefinite in the sense that it has variable extremities which cannot be recognized. The tests were accordingly repeated with a metal ring as object. Difference was not detectable between the measurements of the plain ring and those with a foetus superimposed. The result of correction by our own method and that of Cave will be given to show how the accuracy of the latter method is impaired, because the act of measuring has to be more precise in Cave's method than in our own.

The internal diameter of the metal ring was 15.0 cm., and the measured OF distance was 17.0 cm. Exposures were made at 150, 100, and 65 cm.

At 150 cm. the ring diameter on film was 16.91 cm.
At 100 cm. the ring diameter on film was 18.10 cm.
At 65 cm. the ring diameter on film was 20.20 cm.

Correction for the diameter is as follows:

At 100 cm $-$ $18.10 \times 83/100 = 15.023$. (0.02 cm. error)
At 150 cm. $-$ $16.91 \times 133/150 = 15.00$ (0 error).
At 65 cm. $-$ $20.20 \times 48/65 = 14.91$ (0.09 cm. error).

With the three vertical shift combinations the results for the diameter (Cave) are as follows (Experiment III).

EXPERIMENT III.

Tube shift (cm.)	Diameter (cm.)	OF value (cm.)
100 and 150	14.95 (error 0.05)	17.40 (error 0.40)
65 and 100	15.18 (error 0.18)	16.15 (error 0.85)
65 and 150	15.03 (error 0.03)	16.63 (error 0.37)

It can be seen from these figures that the Cave calculation gives an error which is considerably greater than that of the simple method.

CONCLUSIONS.

After an exhaustive consideration of details of current radiological technique in assessing the capacity of the female pelvis, it is necessary to state what in the present state of our knowledge can be demanded of X-ray pelvimetry.

First the area of the outlet (plane of least pelvic diameter) can be found. The error may be as high as 10 per cent, but it has been shown when such a high error may be expected and how to aid correction. While it is unfortunate that the antero-posterior diameter cannot be precisely estimated by any radiographic technique, the measurement can be made directly with callipers with an accuracy to the nearest 2 to 5 mm.

Second, if it is considered necessary or desirable to have a picture of the pubic arch, the technique is particularly simple, and the results indeed the most reliable

that Roentgenography can provide. The measurements of symphysis, intertuberous diameter, and depth of the pelvic basin vary by about 1 mm. from the true ones, and the subpubic angle is unchanged.

Third, the calculation of the area of the pelvic brim plane was an important objective of the investigations reported here. The results of such a study on a collection of skeletal material are given in Part I. Roentgen studies have, however, shown that by our method the greatest transverse diameter of the brim cannot be found, and we submit that this is not possible by any method, stereoscopic or otherwise. Experiment has shown that intra-pelvic space as seen in the A.P. view is encircled by a shadow of bone which is not, as has heretofore been imagined, the iliopectineal line. The lateral portions of the girdle seen on the film represent the bony wall at or about the depth of the plane of the cavity of the pelvis. Anteriorly the iliopectineal line is clearly demarcated for varying distances. Its continuation even as far as the iliopectineal eminence is frequently stimulated by the anterior and posterior margin of the obturator foramen, the outer or inner edge of the superior aspect of the superior pubic ramus, and osseous ridges near the ischial tuberosities. But it is not the purpose of the present communication to enlarge on this question of anatomical details which complicate the interpretation of films.

It has frequently been stated that the true conjugate lies at a higher level than the transverse of the brim,[12, 7] and this is universally recognized to be true for pelves excluding those with four-piece sacra and a small percentage of specimens with five-piece sacra. In X-ray pelvimetry this observation must now be recognized to have lost its importance, in spite of the fact that an accurate estimation of the conjugate length can be gained from a lateral view film on which the anterior part of the sacral promontory is invariably visible. The anteroposterior diameter of the A.P. view excludes the greater part of the promontory, all of which cannot be shown on any film, whatever its quality. What is seen posteriorly of the termination of this diameter is at the level of the 2nd sacral vertebra in a high preponderance of pelves.

For these reasons we may estimate the area of a plane narrower than that of the superior strait by taking into consideration only the intra-osseous space of the film seen as an interrupted curve. If previously we considered the major portion of this curve to be a shadow of the brim, we may have the consolation now that it is a narrower part of the girdle, and is at least of more significance in obstetrics than a wider plane above. The anatomist has directed his attention to the brim, to the neglect of the plane of the cavity. For academic reasons it would have been gratifying to collaborate with the anatomist in the radiological field, but even if the Roentgen ray has failed us here it has given its virtue to the obstetrician. The pelvic brim index of Turner cannot be used in radiographic work, but a similar index may be used for the cavity plane we have been discussing. This cavity index is likely to give a slightly higher figure than Turner's, and for 50 Bantu antenatal and postnatal women it gave a mean of 91.28 against a female Bantu mean for skeletal material of 90.4 (65 pelves). One is diffident about making new recommendations, but it may be of value to follow the argument a little further for the brim index and area. Certain possibilities for these values immediately present themselves once there is recognition of the fact that the skiagram will give an index and area for the cavity plane only.

It appears, from the observations at our disposal, that the greatest transverse of the brim obtained from A.P. films is in the region of 7.5 mm. shorter than on the pel-

vis, the range being from 5.0 mm. to 10.0 mm. The conjugate diameter of the film, in which we disregard the promontory, shows a gain posteriorly. In the 60 pelves studied in Part I dioptographic tracings were made (see Fig. 1), and the antero posterior length from the anterior surface of the promontory to the modified curve posteriorly was measured. The mean for this distance in 60 pelves was 14.7 ± 1.13 mm., with a range of 5.0 mm. to 25.0 mm., and standard deviation 4.36 mm. The gain in the conjugate is thus 14.7 mm. The distance from the iliopectineal line on the symphysis was measured to the most posterior portion of the symphysis shown on the skiagram. In 50 antenatal and postnatal Bantu women the mean for this distance was 13.1 ± 0.52 mm., with a range of 9.7 mm. to 19.1 mm., and a standard deviation of 1.83 mm. Considering the innermost girdle of bone which is shown by the X-ray to enclose space, we have an antero-posterior diameter which on the average, compared with the conjugata vera, suffers a loss of 13.1 mm. anteriorly and a gain of 14.7 posteriorly. This mean would apply with accuracy to a series of measurements, but may err considerably in a specific case. For a series, therefore, this X-ray conjugate can be said to be almost equal to the anatomical true conjugate. As, however, the X-ray transverse diameter is about 7.5 mm. shorter than the brim transverse, the index derived from (film conjugate ÷ film transverse × 100) should be a little higher than the Turner brim index. It would be valid to state that this index is of value, because the bulk of the figures in future will be derived from radiological observations. Whereas the few have studied skeletal material, increasing numbers of observers will be reporting X-ray findings. Moreover, the index here analysed bears comparison with the Turner index itself, in spite of the fact that the two values are for slightly different levels of the lesser pelvis. In our observations, the mean Turner index for 65 female Bantu dry pelves was 90.4 ± 2.0, S.D. 8.2, and range 69.6 to 104.4. In the suggested X-ray index the figures for 50 Bantu antenatal and postnatal women were: mean 91.28 ± 1.7, S.D. 6.0, range 79.1 to 110.8.

If it is desired to calculate the area of the brim plane in a particular pelvis, but with greater precision for a series of pelves, the modification necessary is based on the following observations: the transverse axis of the ellipse is approximately 7.5 mm. too short, and the anteroposterior axis is of the correct length. If the latter axis is measured anteriorly on the film to about the middle of the posterior surface of the symphysis pubis—rather as in measuring the "obstetric" conjugate on skeletal material—we gain half the width of this pectineal shadow which on the average is 13.1 mm. Thus, in this modification a figure for the anatomical brim area is very closely approached.

Apart from studies during labour, it is difficult to see that a lateral view film can contribute much to our knowledge of any pelvis concerned in an obstetric prognosis. The true conjugate can be found, but is of negligible value taken by itself; and much is made of the greater sciatic notch by some obstetricians. Academically this notch is of unbounded interest and importance, but in practice it is only of indirect value in showing how long the iliac portion of the inlet is. This can be seen directly in the A.P. view with greater certainty and here too the distance of the ischial spines from the sacrum will give all the information of practical value. The early workers made curious statements about X-ray plates showing the thickness of the sacrum, "the presence or absence of atrophy of the sacrum or of sacro-iliac ankylosis" (Pinard and Varnier[13]), and so on. These men

were pioneers and deserve only our admiration, but one feels that we have not advanced since their time, when we insist on the necessity of seeing the sacro-sciatic notch radiographically. One submits that the clinician can derive from the A.P. view with horizontal brim all that the Roentgen ray can teach about the average pelvis, that a photo of the pubic arch will be required in some cases, and that a lateral view will be taken to complete the information required only in special cases.

PART III.

The Present-Day Status of X-ray Pelvimetry.

When Varnier and Chappuis[14] in 1896, first radiographed the pelvis, an era of great promise for obstetrics was opened. The half-century which has followed, though a period of intensive research in many branches of knowledge, has failed to bring the conviction that every primigravida should have the pelvic girdle radiographed. For this diffidence on the part of the accoucheur there are several reasons which in no way reflect on the inconvenience, danger, or cost to the patient. Whereas the pioneers mentioned required exposures of 3 hours to gain pelvigraphs from the cadavera experimented upon, and the first pelvic skiagram of the living subject was obtained with an exposure of 45 minutes, the patient of to-day is detained by the radiologist for a total period of about 10 minutes. The danger to the mother and foetus is negligible, and the cost for obtaining two views is less than that of a blood count. The obstetrician recognizes his conspicuous limitations concerning the prognosis in a case of disproportion, but he would gain small comfort from the possession of an indifferent X-ray picture of the pelvis in question. He is unable to use this shadow and, even if it were accompanied by some measurements, he is distrustful of such phantasies. It is, however, dawning on him that he must be considerate of this handmaiden who has taught him much that he can learn in no other way; and as his understanding increases he will return with a fuller knowledge of what he should seek to discover from this source. The momentum which radiology can give to advancement in the study of parturition is reciprocal to what obstetrics may demand of radiology. Until there is a universal employment of X-rays in this sphere, we shall progress but slowly; for it is submitted that we do not yet know the pelvic factors that are essential to eutocia, and that the skiagram is the only means to bridge this gap.

Much is written about X-ray pelvimetry, and many methods are advocated. The obstetrician is dazzled by performance and complexities which are hurled at him rather than given to him. He is not an investigator, but has a sincere desire to enlist such aids as he understands. It is necessary, therefore, to avoid complexity and, if possible, to provide methods which he can personally carry out.

Now there are two shades of opinion born of the mysticism of pelvic radiography. Whereas it has always been possible to measure the intact pelvis approximately, it was impossible to gain an impression of its architecture until X-ray photography came into being. It was novel, but incidentally easier, to assess a pelvis on morphological grounds—and thus we have a vogue. The older approach to pelvic capacity was based on mensuration, and X-ray pelvimetry was a natural gradation. But this new pelvimetry was ill at ease, and some of its adherents resorted to the study of shape and form instead. It seems desirable to have a full knowledge of our subject and not to abandon the more precise moiety,

even if at the moment we are unable to equate the values of mensuration.

Albert[15] seems to have been the first to suggest that the pelvic brim should be parallel to the film lest diameters in this plane be distorted. This obvious basic principle was neglected for a generation for reasons that can only be surmised. In the early days there was no Potter-Bucky diaphragm, and good pictures were only rarely obtained. For many years measurements were obtained by comparison with a standard dry pelvis X-rayed in the same position as that of the subject. Varnier[16] used a focus-film distance of 5 metres in order to enable him to take measurements not requiring any correction. Orley[12] states that Varnier succeeded in obtaining an outline of a dry pelvis at 25 metres distance with an exposure of only 10 minutes. But technical difficulties must have been so formidable that it is not surprising that Varnier's teleroentgenographic method never found favour. It is necessary to point out that as early as 1897 Levy and Thumin[17] used the so-called mathematical method: their simple equation contained as one factor the cosine of the angle of pelvic inclination!

In the simpler mathematical methods, because certain measurements such as the height of the brim above the film had first to be made, there was a lack of precision. Precise methods were, however, evolved, and in 1924 Blanche and Portes[18] devised a simplified technique which was mathematically accurate. It is shown elsewhere in this paper that, nevertheless, there is a liability to error in practice, while for the clinician too many exposures of film may be required. Paul Cave[7] modified the method of Blanche and Portes, and shows how the object-film distance may be calculated with precision if two films are obtained, after making a vertical shift of the tube for the given object. Hastings[19] described a similar method, using a horizontal side-to-side shift. For certain practical purposes it is reassuring to be able to fall back on accurate methods such as these, but for general use workers will begrudge the expense and trouble involved.

Stereoscopic methods had been favoured by some investigators, but only when Moloy[20] described his precision stereoscope did it become generally known that the stereoscopic image could be measured. While the principles underlying Moloy's technique had been in use for many years, the difficulty lay in imitating in the stereoscope the set of circumstances that prevailed during exposure of the films. By Moloy's ingenuity the technique was standardized in the design of his instrument. Caldwell, Moloy and their co-workers [21, 22, 23, 24] have concentrated their attention on foetal pelvic relations during labour: their studies are predominantly concerned with pelvic architecture, and where they anticipate disproportion the image of the pelvis is measured in space. The radiography during labour is unquestionably of great value, but the expense and labour involved put their methods out of reach of the average clinician. It may also be doubted whether stereoroentgenography of this kind will be the method of the future, although to the investigator it will always be of advantage, an assumption borne out by the importance of the discoveries made by these workers.

Measurements obtained from the precision stereoscope in which an anteroposterior tube shift is employed are not universally accurate. The "phantom ruler" must be held exactly in the plane to be measured, and when the diameter concerned is the conjugata vera one has even to know the slope of the plane, it being impossible to be precise about this. By this method there is the same difficulty about seeing the promontory shadow as

exists in other anteroposterior views, and the impossibility of seeing the true transverse diameter of the brim is the same as described elsewhere in this paper. So much practice is required with this stereoscope that there must be a tendency to accept with reserve some of the measurements obtained.

With reference to the coronal plane used by Caldwell *et al*[21, 24] one cannot accept that if the ischial spines lie in this plane the greatest transverse diameter of the superior strait will always lie in this coronal plane. A study of skeletal material will show that this assumption is by no means always correct.

Nicholson's[8] method is a stereometric one which is ingenious and theoretically accurate to the nearest millimetre, or as precise as the X-ray shadow enables one to be. He uses a stereometric shift of 10 cm. and obtains the true diameters not by viewing in a stereoscope, but by marking on tracing paper the stereometric shift of the terminal points of diameters required, and joining these points to the corresponding points at which the projection of the focus of the tube is shown. If a diameter lies in a plane oblique to that of the film this is detected by the shift of its termini being unequal. For the purpose of correction in this case, tables are presented. These films can further be used to give a stereoscopic view as relied upon by Caldwell *et al*. Nicholson's method of measurement requires more time for each case than does the precision stereoscope; but it can be used by anyone not possessing this instrument, and is certainly more precise and scientific.

Nicholson's technique demands two films for the inlet view, and two for the pubic arch. In the method suggested in this paper, one film only is required, and a second where the pubic arch is suspect. In the latter method there is greater simplicity for the clinician, and his purpose is served equally. But the stereometric method is extremely valuable to have at our disposal, and there is much to be said in favour of its adoption by anyone but the occasional worker, i.e., by the investigator and workers in large obstetric hospitals. If Nicholson's paper has not met with the acceptance it deserves, it is because he has assumed too much in explaining the principles involved, both mathematical and technical. In studying the paper even a trained mathematician would have to spend an unjustifiable amount of time and thought on this method—and it has been published in a medical journal! It is, however, a method which has our full support. It was observed that this author published a paper in February 1943 on the same subject. Owing to war conditions that particular number of the journal failed to reach this country, and it has been impossible to follow any new ideas that may have been expressed by him.

Apart from stereoscopic methods there are the position methods, and here it is necessary to refer to some basic principles involved rather than to deal in detail with the technique employed.

In Thoms'[11] grid method we have sufficient accuracy for inlet measurements, provided we bear in mind the fact shown in this paper that the plane of the brim cannot be seen on an A.P. film. The technique has been found to be more cumbersome and to give results inferior to those obtained in the suggested method. Thoms'[16] modification, in which he uses Rowden "pubic scales" and calculates the height of certain planes on a lateral skiagram, is mathematically unsound when applied to the ischial spines and comparable landmarks. While the latter error may not be great, he does not mention its range.. The method of choice should be simple, with a clear statement of the limits of the possible

error, for it is imperative that too great an error be avoided even if occurring only in the exceptional case. Roberts[25] places the patient so that the brim is parallel to the film, and does not require a centimetre grid: the correction is made by the simple calculation used in the method of the present paper. Rowden[26] varies his technique from Roberts' in two respects: "pubic scales" are prepared for correction at varying distances of the inlet plane above the film, and the focus-film distance used is 4 feet 6 inches (preferably 6 feet). His exposure is for 25 seconds, the symphysis being shaded with a hatchet for half the time. The further the target is from the film the better, but an exposure of 25 seconds must result in too great movement on the part of mother or foetus.

Because our own method relies on a horizontal inlet, it is necessary to refer to some points made by Roberts and Rowden. Rowden[27] is in error when he states that a semi-recumbent position at an angle of 55 degrees ('it really ought to be $57\frac{1}{2}$ degrees') will make the brim horizontal. Even if the pelvic inclination in the erect posture be known in a given case, it is incorrect to think that the plane of the brim moves rigidly with the trunk. In passing from the erect to the recumbent position the individual describes a right angle, but the brim does not rotate through 90 degrees, because the recumbent position is usually associated with more lordosis than the erect. Similarly, when the patient leans against Roberts' back-rest there is a tendency to lordosis which would interfere with Rowden's mechanism for securing a horizontal brim at a 55 degree semi-recumbency. Rather than accept assumptions of this nature, the height of the pubic symphysis above the table and the height of the sacral promontory (spine of last lumbar vertebra) must in every case be measured and made equal, in order to be sure that the inlet is horizontal. Unless the effect of lordosis is appreciated it will often be found that the patient is sitting straight up before the inlet becomes horizontal.

Rowden[26, 27] assumes that the inlet is horizontal, and accordingly measures only the height of the symphysis above the table. Roberts[28] measures the distance from symphysis to X-ray tube. There is, then, a possibility that their inlets in some cases may be oblique and become appreciably distorted, and this is avoidable. Rowden[27] states categorically that, if a projection of the obturator foramina is not seen in this view, the position is correct. This is only approximately true. The brim can lie at a small angle to the horizontal without the obturator foramina appearing in this A.P. view; and conversely, in the exaggerated convergent android pelvis a part of the foramina may be seen posterior to the symphysis. The writer has observed this in skeletal and living material when there was no question of the brim being parallel. Rowden[27] gives his height of symphysis above table as 12.0 to 14.5 cm. ($4\frac{3}{4}$ to $5\frac{3}{4}$ inches). In our experience the range is from 10 cm. to about 13.5 cm., though the latter figure may later increase.

From Orley's[12] paper, and the discussion that followed, one gathers that he, and Martius, and Rowden are unaware of the impossibility of showing a radiographic shadow of the lateral portions of the iliopectineal lines. Martius is said to have evolved a method of calculating the surface of this plane. To this Orley objects and points out that on the average the transverse of the brim lies on a level lower than that of the conjugata vera. Rowden criticizes Orley's statement, and suggests that a 6-foot focus-film distance will nullify the effect of the error of the two planes. Whatever variation is adopted to correct the figures, it is of some importance to realize that one does not see the anatomical inlet

on the film, but a level which lies close to the plane of the cavity.

Roberts[28] refers to the importance of measuring the oblique diameters of the brim accurately. To ascertain the presence of asymmetry of the brim one would inspect it and, when necessary, measure the two oblique diameters. The iliopectineal eminence is so large a mass of bone that even on the dry pelvis the oblique diameter is difficult to standardize. One recommends, therefore, that for comparative purposes the diameter be measured from the sacro-iliac joint to a line drawn parallel to the line joining the tips of the ischial spines—preferably a line in the region of the iliopectineal eminences. He also demands an accurate measurement of the pubosacral diameter in some cases, suggesting the Chassard and Lapine[9] technique. It is shown in this paper that the antero-posterior diameter of the outlet cannot be measured radiologically, not even on the lateral skiagram, although theoretically Nicholson's stereometric method approaches accuracy very closely even in this instance.

Jacobs[10] brings the film parallel to the superior strait after measuring the pelvic inclination with his inclinometer. The principle underlying his method is good, but one is doubtful of the accuracy of his inclinometer. In the first place he has to measure the width of the symphysis pubis directly, an error of $\frac{1}{2}$ to 1 cm. being readily made. Secondly, he cannot often feel the sacral promontory in the supine position with thighs unflexed, and must rely on his judgment for the direction in which the inclinometer rod is passed through the vagina. Thirdly, the inclination of the superior strait does not necessarily rotate through the same angle as does the body to reach the supine position. It is possible that the resultant error is small; but its magnitude in a few cases may be significant, and there is no way of suspecting in which cases the error is serious. For these reasons the elaborate technique does not appear to justify itself.

In the following statement Jacobs[10] does not mention the focus-film distance, nor does he at any time state the distance he uses: "experimenting with the bony pelvis, I have shown that discrepancy of only 5 degrees between the inlet and film produces an error of 0.5 cm.; an error as great as 1 cm. could easily be encountered." If such a statement were harmless as well as meaningless one would disregard it; but it may mislead the uninitiated!

There is an impression that Ball[29, 30] has reduced the degree of disproportion between head and pelvis to simple mathematical terms. Ball chooses a pelvic diameter and replaces the figure by the volume of the sphere having a diameter of the same length. A similar volume for the foetal head is calculated, and it is considered that this should not exceed the "pelvic volume" for a particular level by more than 150 c.c. If so, the disproportion is dangerous. If this concept is compared with the consideration of the area of a pelvic plane and the area of a cross-section of the foetal head, the former must surely be declared to be inferior.

Summary and Conclusions.

1. The value of X-ray pelvimetry is considered and simplicity in technique advocated. There are two objectives: the first is to reach a decision about the salient features of a pelvis which will give both its capacity and type; the second is concerned with the limitations of radiography in providing these desiderata, and can only be fulfilled by experiment showing the degree of precision of certain technical methods.

The conclusion reached is that, at the present, X-ray pelvimetry is precarious,

but that with simplified technique we may attain to results of such value that every primigravida should be radiographed.

2. Dioptographic tracings were made of the pelvic brim and the outlet plane of least pelvic diameter of a collection of skeletal material. The outlines were considered as ellipses, their areas found with a planimeter, and compared with the calculated area. In the case of the brim a mean error of −8.5 per cent was thought to be too great, and a modification introduced which gave an error limit of less than 5.0 per cent. For the outlet, the calculated area may show an error up to 10.0 per cent, but it is shown how this error may be reduced.

3. A new method of obtaining the distance between the ischial spines is shown. The error is less than 1 per cent, which amounts to being less than 1 mm. With the pelvic brim horizontal, the ischial spines are in all cases very close to 3.0 cm. from the table surface, and this makes the calculation possible.

The pubosacral diameter cannot be measured precisely on a lateral view film, because the anterior point is indeterminate. Even by Nicholson's stereometric method the posterior point inaccuracy is too great to warrant the expense and trouble of exposing a film for this diameter only. Clinical measurement is at least as accurate, and figures are given to show what subtraction for the sacral thickness is necessary in this case.

4. The level of the spine of the last lumbar vertebra, relative to the pelvic brim and promontory, is discussed fully. With the brim horizontal, the last lumbar spine is at the level of the conjugata vera. It is shown how lordosis aids in producing a horizontal true conjugate with a semi-recumbent position convenient for X-ray work.

5. An antero-posterior view in the above position provides the areas of inlet and outlet, and an inlet index. No more than this is required for practical purposes except to palpate the pubic arch for height, width, and the height of the symphysis pubis. If the arch is suspiciously narrow, a radiograph giving accurate measurements can be obtained simply. It is considered that a lateral view of the pelvis is very rarely of value.

6. Unsatisfactory results with the transverse diameter of the brim led to experiments which show that by no X-ray method can the actual transverse of the brim be shown. This inlet seen on the skiagram represents a level near to that of the pelvic cavity. The iliac portion of the iliopectineal line cannot be seen on any film, and its anterior portion is usually simulated by other anatomical features. It is, therefore, impossible by radiographic means to obtain measurements of the superior strait, i.e., excluding the conjugata vera on the lateral film. The estimation of the area and the pelvic brim index for this level is discussed, and a solution offered.

7. A survey is made of the achievement of different X-ray methods of studying the obstetric pelvis. The conclusion remains, that our method of making only one exposure for the average case gives as much information for practical and clinical purposes as can at present be expected from radiography.

I have pleasure in acknowledging my thanks to the honorary radiologists of the Johannesburg General Hospital for the facilities allowed me, and their interest in my work; and to Miss E. Brown, chief radiographer at the non-European X-ray Department, and her staff for their patience in carrying out my radiographic work.

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The Effect of Testosterone Propionate on Two Cases of Ovarian Carcinoma

BY

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ATTENTION has been given lately to the treatment of advanced carcinoma of the prostate and of the breast with oestrogenic substances. With the knowledge that androgenic substances had an inhibiting action on the normal functions of the female genital organs producing a complete cessation of menstruation if given in sufficient dosage, it seemed feasible to try its effect on advanced ovarian carcinoma.

The difficulty that presented itself was the heavy cost of the material. Thanks to a grant by the Medical Research Council and to the generosity of Messrs. Boots who, besides themselves giving a considerable quantity, supplied the rest at cost price, it has been possible to try out its effect on 2 cases.

The first, a woman of 51, was seen in October 1942 complaining of post-menopausal bleeding. She had had a radium menopause 7 years previously because of continuous uterine bleeding for 9 weeks.

Seventeen years previously the left breast had been removed on account of carcinoma. She had had 4 normal pregnancies and labours, and until the time of the irregular bleeding, for which radium treatment was carried out, her periods had been normal.

On abdominal examination a firm, smooth, tender mass was found rising to the umbilicus. *Per vaginam* there was a small mass felt through the posterior fornix continuous with the abdominal tumour, the whole being slightly mobile and tender.

A laparotomy was performed in early November and the tumour was found to be a cyst growing from the right ovary, which was removed. The other pelvic viscera were normal, and there was no free fluid or other suggestion of malignancy present.

On opening the cyst there were found to be a number of intracystic papillary growths which proved on section to be adenocarcinoma.

During January 1943 the patient was given a full course of deep X-ray treatment to the pelvis. In April 1943 careful examination gave no evidence of any recurrence and the patient was herself well.

In November 1943 there was some evidence of thickening to the left of the uterus which rapidly increased, and in March 1944 she was readmitted and the abdomen again opened; it contained a considerable quantity of free fluid; the pelvis was filled with a mass of growth and secondary nodules were scattered over all the viscera.

A peritoneal nodule was removed for biopsy and showed the presence of columnar celled carcinoma, much of which was undergoing a squamous metaplasia, the growth being surrounded by a considerable amount of fibrous tissue.

From March 20th, 1944, until May 30th, 1944, injections of testosterone propionate were given, daily at first and then on alternate days until a total of 6,750 mg. had been reached. The patient felt rather better in her general health, was more cheerful, her appetite improved, and for a time she gained a little weight. She went home on

May 30th, 1944, with further bi-weekly injections until July 7th, 1944, the final dose bringing the total to 7,200 mg.; During the period at home she rapidly deteriorated. She suffered from severe epigastric pain and was frequently sick. She was readmitted to hospital on July 13th, 1944. By this time the abdomen was distended with a firm irregular growth and her pain was severe. Considerable quantities of narcotic drugs were necessary to give relief. She slowly went downhill and died on September 6th, 1944.

Postmortem examination showed the abdominal cavity filled with pinkish grey carcinomatous tissue invading all the organs. Apart from the direct spread there was no evidence of secondary deposits in other parts of the body. Histological examination showed a mass of solid alveolar and trabecular and diffuse, polygonal, spheroidal and rarely giant celled carcinoma. Some of the tumour cells were secreting mucus. Many small foci of calcification were present amid the tumour cells. There was invasion of the uterus, liver, ileum and skin by the growth.

This patient did not develop any deepening of voice or growth of hair on face or body which is associated with the administration of large doses of testosterone.

The second case was a patient of 75 who came to hospital on December 30th, 1943, complaining of pain in the left side of the lower dorsal region of the back for 3 months. It was a dull continuous pain radiating to the hypogastrium and relieved somewhat by rest. There was an inclination to constipation; no blood or mucus in the stools; micturition normal; no vaginal discharge.

Abdominal examination revealed a mass arising from the pelvis and reaching to the umbilicus. Vaginal examination showed it to be continuous with a mass in the pouch of Douglas.

Blood count: Red blood corpuscles, 4,400,000; haemoglobin, 85 per cent; white blood corpuscles, 19,750.

X-ray showed lateral wedging of T. vert. 11.

She was thought to be an advanced carcinomatosis of ovarian origin.

Her general condition was poor and did not warrant any major abdominal operation. So on January 27th, 1944, under local anaesthesia with a little gas and oxygen, a small subumbilical incision was made. A large ovarian tumour was found, with necrotic walls, and a small piece was removed for biopsy. There was no sign of local peritoneal spread.

Between February 15th, 1944, and February 20th, 1944, she suffered from diarrhoea controlled by bismuth and opium.

From February 25th, 1944, to April 6th, 1944, she was given 75 mg. of Testosterone Propionate daily, by intramuscular injection, in all 3,150 mg.

For the first fortnight she felt much better and had more energy, but gradually she went back with marked pain in the region of the 11th thoracic vertebra. She had a short course of deep X-rays to the thoracic region with a view to the relief of the pain, but without effect, and she went downhill quickly and died on April 22nd, 1944.

Postmortem examination revealed a large necrotic tumour of the right ovary and a smaller one of the left ovary; a papilliferous tumour in the region of the ileocaecal valve.

Extensive metastatic deposits in the liver and a cavity in the body of the 11th thoracic vertebra containing pus were found.

Histological examination showed an ulcerated tubular columnar celled carcinoma of the caecum, with a tendency to form intracystic papillae; in one place the growth had penetrated the whole thickness of the gut. Section of the ovarian

growth showed a carcinoma of a similar structure. Sections from the liver and the vertebra also showed secondary carcinoma.

The examination suggested that in this case the primary growth was in the large intestine.

These 2 cases, one undoubtedly a primary ovarian carcinoma, were both given testosterone propionate; in the first case in fairly massive dosage. The immediate effect in both was to give the patients a feeling of well being, but this was only temporary and there was no evidence of any retrogression in the growth itself or the metastastic deposits, either clinically or histologically.

In the *American Journal of Obstetrics and Gynecology* (December 1943), C. T. Beecham reports on 6 cases of ovarian carcinoma treated with testosterone propionate with somewhat corresponding findings.

But for the heavy cost of the testosterone propionate it might be well to try its effect on an advanced carcinoma of the uterine endometrium, as being the end organ on which the gonadic hormones act and therefore more likely to be influenced.

My thanks are due to Dr. J. Bamforth and Dr. R. John for their help with the histological examinations.

Note of a Case of Extrophy of the Bladder with Procidentia

BY

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THIS case is recorded for two reasons. I can find only 2 other cases of ectopia vesicae with procidentia in the literature, though it would be reasonable to expect prolapse to occur fairly often in patients with wide pubic separation, and if attention is drawn to the possibility other cases may be recorded. Secondly, the combination does present a difficult problem, and a note of present experience may assist other surgeons.

The patient was aged 31, and was first admitted to Leatherhead E.M.S. Hospital in October 1939. She had already endured much surgery; before 5 years of age she had 8 operations in the Hospital for Sick Children, Great Ormond Street, and although the notes are not now available, it is believed that both ureters were transplanted into the bowel and attempts were made to close the abdominal wall. When she was aged 25 she was first seen at King's College Hospital by Mr. J. G. Yates-Bell, and I am indebted to him for the following information. When he first saw her there was a large cavity in the suprapubic area, lined by reddish mucosa. A fistula between this cavity and the sigmoid colon was demonstrated, and both faeces and urine (via the transplanted ureters) escaped through the cavity, and also through the rectum. In successive stages the ureteric anastomoses were refashioned in fresh bowel (further from the fistula) and the fistula closed, the parietes being drawn together as far as possible. A final granulating area was covered by pinch grafts.

As is usual in these cases, the pubic rami and labia were widely separated, and the position of the symphysis and *mons veneris* was occupied by a narrow bridge of skin and fibrous tissue. The perineum was normal. At times the cervix protruded just outside the vaginal orifice, and the anterior vaginal wall was everted below this bridge of skin. The prolapse was controlled by a cup and stem pessary. In 1936 right renal calculi were removed by pyelolithotomy, but further renal infection with poor function on that side necessitated nephrectomy in March 1939.

When the patient came under my care in October 1939 she was complaining of severe discomfort due to her prolapse. Her general condition was good, with a blood-pressure of 126/90 mm. and a blood-urea of 37 mg. per 100 c.c. Her urine could not be examined as it was discharged rectally, but her temperature chart did not show any evidence of further renal infection and intravenous pyelography showed a normal left kidney with good excretion. She could hold her urine rectally for 2 hours.

By this time the prolapse was complete, and the whole vagina was everted, with severe infection and crusting over the mucosa. The local inflammation was so severe that she could not use her cup and stem pessary, and could not walk or sit in comfort. Her periods were regular and normal, but she found menstrual hygiene most difficult. She refused to consider any further use of a pessary and gladly con-

sented to an attempt at surgical cure, though success could hardly be promised.

It was felt that vaginal hysterectomy and repair would have many advantages over less radical procedures, as pregnancy would be a grave danger to her renal health, and it was hoped that the stretched cardinal ligaments could be more effectively sutured after removal of the uterus. In the absence of the normal fascial layers of the anterior vaginal wall, the whole success of any repair would depend on these ligaments. Interposition was not feasible; le Fort's operation was undesirable at her age; and any intra-abdominal fixation was impossible as the lower abdominal wall was only represented by an attenuated scar. There was one real risk—injury to the one remaining ureter—the precise point of entry of the transplanted ureter being unknown.

After some days of local preparation, operation was performed under gas, oxygen and ether anaesthesia. The posterior fornix was first incised and the pouch of Douglas sought. It was obliterated by adhesions, but the posterior wall of the uterus was fairly easily followed by gentle dissection, the distended rectum being pushed backwards, and freed with a little more difficulty from the fundus of the uterus, where rather denser adhesions were encountered. The "Fothergill incision" was next made down the anterior vaginal wall and around the cervix, and the anterior wall of the uterus dissected free from a mass of fibrous tissue that occupied the normal place of the bladder. When the fingers met over the fundus of the uterus, the broad ligaments were defined and clamped in the usual way, and the uterus removed. It was interesting to observe that the supravaginal part of the cervix was elongated just as in the ordinary case of prolapse. The broad ligaments were sewn together, and the usual anterior wall repair done. In view of the gross local sepsis and some fear for the vitality of the rectal wall after its separation from the uterine adhesions, a little packing was placed in the posterior fornix, which was not completely sutured, but left to granulate. A rectal tube was passed to drain urine freely from the bowel and prevent distention.

Recovery was uneventful. So far as the position of the fornix was concerned the immediate result was good, but it must be admitted that there was still some bulging of the anterior wall, where the normal pubocervical supports were deficient. The mucosa soon recovered its normal moist surface and pliable consistence, and the local infection subsided. The patient was delighted with the result and in 1942 wrote to tell me that she had married, and when I saw her did, indeed, seem a different individual. In 1943 she was seen again and, as it was feared that the anterior wall bulge was increasing, she was given a modified ball and stem pessary, which she was able to wear with comfort. If in the future this eversion still progresses then there will be no alternative but to perform some type of le Fort procedure.

The only record of a similar case[1] that I can find was that of a Sudanese woman, aged 25, and in that case transplantation of the ureters was the only treatment, and there was no attempt to deal with the prolapse. One other case of ectopia vesicae complicated by procidentia was reported by Bonnet[2] as long ago as 1723, but in that case the prolapse followed the free division of the perineal body to complete a difficult delivery, and the brief account does not mention treatment. Several cases of pregnancy in patients with extrophy of the bladder have now been reported, and it would be interesting to know if any of these subsequently developed prolapse.

In the present case complete success in treatment of the prolapse cannot be

FIG. 1.

Showing postoperative result. Note the wide separation of the pubes, the abdominal scar and the bulging anterior vaginal wall.

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claimed, but enough was achieved to allow the patient to marry, and to rid herself of that feeling of inferiority that so often goes with gross developmental abnormalities. Her ultimate prognosis depends on the fate of her remaining kidney, and a few recent attacks of pain in the loin with fever suggest that some ascending infection must be feared. The photograph (Fig. 1) shows the result, with the wide pubic separation, the abdominal scar, and the bulging anterior vaginal wall.

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Extragenital Chorionepithelioma

Report of a Case with Chorionepithelioma of the Breast occurring during the Course of Pregnancy.

BY

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A STUDY of the literature on chorionepithelioma shows that two main varieties of this rare condition exist.

The first, which is known as Genital Chorionepithelioma, is the more common type described in all modern textbooks of gynaecology. As the name suggests, the genital tract is primarily involved by the growth, secondary deposits manifesting themselves in the lungs, liver, brain, and other organs.

This group may be further subdivided into two varieties depending on the site of origin of the neoplasm.

(1) *Uterine chorionepithelioma*, first described by Sänger[1] in 1889 as deciduoma malignum, and now generally recognized as the commonest site of origin of this type of malignant growth.

(2) *Extrauterine chorionepithelioma*, characterized by the presence of a neoplasm in the genital tract without any microscopic evidence of its presence in the uterus. The commonest site of these growths is the vagina, and has been described by Zagorjanski-Kissel,[2] Findley,[3] and others, as primary vaginal chorionepitheliomata. Dougal[4] and others have described the occurrence of primary ovarian chorionepitheliomata and Cope and Kettle[5] the presence of primary growths in the Fallopian tubes.

The second main variety, which I propose to deal with in this paper, is the Extragenital Chorionepithelioma, in which chorionepitheliomatous growths have been found in other organs of the body, remote from, and without any evidence of a similar growth in, the genital tract. Dunger[6] spoke of such instances as examples of "ectopic" chorionepithelioma.

LITERATURE.

Although genital chorionepithelioma is often described in the English literature, I have been unable to trace any recorded case of the extragenital variety except in the American and Continental records.

The first recorded case of extragenital chorionepithelioma was described in 1900 by Davis and Harris,[7] in a woman aged 40 years who had been pregnant 14 times Her youngest child was 14 months old. She was admitted to hospital in extreme prostration with a history of 2 months' amenorrhoea. Describing the case in their own words—"early pregnancy was diagnosticated. No improvement in her general condition occurred and the uterus was dilated and emptied under ether. She, however, did not regain strength, had paroxysmal attacks of vomiting, became at times maniacal, passed urine and faeces involuntarily and died of apparent exhaustion. A probable diagnosis of temporary insanity, of malnutrition and anaemia was made." Autopsy revealed 9 irregular tumour-like masses in the brain, with similar growths in the lungs, left kidney, liver and thyroid gland. The uterus appeared

to be normal. Microscopic examination showed the growth to be a typical chorionepithelioma.

Marchand[8] in 1898 described a case in which neoplastic foci of chorionepithelioma were found in the brain, lungs, and kidney 1 month after removal of a hydatidiform mole from the uterus. No evidence of a primary tumour was discovered in the genitalia. The uterus was found to be "somewhat enlarged and there was decided decidual formation *in utero*."

In 1902, Senarcleus[9] reported the case of a woman aged 38 years who had had 1 child. In 1898 she had an early abortion and in November 1901 there appeared a foul smelling bloody discharge from the vagina, together with severe abdominal pains. In February 1902, i.e. 4 years after gestation, an abdominal tumour was recognized and diagnosed as "a swelling in the right adnexa." Death occurred 1 month later, shortly after abdominal section. Postmortem revealed multiple growths in the lungs, anterior mediastinum, wall of the right ventricle of the heart, thyroid gland, suprarenals, and kidneys. Microscopic evidence of an atypical chorionepithelioma was found in all the above organs. The Fallopian tubes, ovaries and uterus were normal.

In the same year, Busse[10] quoted the case of a patient aged 40 years who entered hospital with a right-sided hemiplegia and who died soon afterwards. Autopsy showed extensive chorionepithelioma of the lungs, liver, kidneys, pia mater, and intestines. The primary growth was not recognized, but the genitalia were not involved.

Fischer[11] in 1913 described the case of a woman aged 45 years, who had had 2 deliveries, the last 18 months prior to admission to hospital. Necropsy disclosed numerous nodules in the liver, varying from 2 to 6 cm. in diameter. There was invasion of the hepatic veins by chorionepitheliomatous growth. The head of the pancreas revealed a similar nodular neoplasm. Microscopy revealed a typical chorionepithelioma. The uterus on examination was normal.

Gurewitsch[12] in the same year, described chorionepitheliomatous growths in the liver, intestine, lungs, and mesentery of a patient aged 31 years, 18 months after a hydatidiform mole. Although the uterus showed decidual changes, no evidence of a neoplasm was found. The ovaries contained lutein cysts.

Christeller and Oppenheimer[13] described an interesting case in 1925, of a patient aged 52 years who died 12 years after a pregnancy. Chorionepitheliomatous deposits were found in the liver, lungs, and intestine.

Nolasco,[14] in 1927, found neoplastic deposits of chorionepithelioma in the lungs, liver, and kidneys of a patient in whom no genital involvement could be found.

In Budapest in 1928, De Zalka[15] reported a similar case to that described by the previous authors. The patient, aged 46 years, whose menses started at the age of 15 years, continued to menstruate regularly up to 35 years, at which time her periods stopped. She had had 5 pregnancies and 2 of her children were alive and well. In February 1920 she observed a small tumour in the right abdominal region, which about 10 months later occupied the entire right abdomen. In January 1921 the patient entered hospital and a large mass, presumably liver, was found extending 8 cm. below the costal margin. Her genitalia, although showing atrophy, were normal. A diagnosis of multiple liver gummata was made, because of a strongly positive blood Wasserman reaction and the presence of "luetic scars" on the lower limbs. The patient became cachectic and the nodular hepatic tumour increased in size. She died 1 month later. At autopsy

chorionepitheliomatous nodules were found in lungs, liver, and kidneys. De Zalka believed that the tumour in the liver was primary as it was the largest tumour, and the uterus did not contain a tumour.

Novak and Koff[16] in 1936 reported the case of a woman aged 31 years, who was admitted to hospital because of headaches and failing vision of several months' duration. Seven months previously vaginal bleeding began. Curettage was performed 2 months later and revealed normal retained products of conception, later confirmed by microscopic section. Death occurred 5 months later and chorionepitheliomatous growths were discovered in the left occipital lobe, lungs, and kidneys. Histological examination of the uterus did not reveal any abnormality.

In 1931, Lapointe, Cain, and Darfeuil[17] found chorionepitheliomatous deposits in the small and large intestines of a woman aged 32 years who died 3 years after abortion.

Four years later Bonne[18] published a case of chorionepithelioma which exhibited foci in the lungs and brain of a woman aged 30 years. A history of pregnancy was not mentioned.

Gerber[19] in the same year, 1935, quoted a case similar to that of Bonne's. Again there was no history of pregnancy. The lungs showed deposits of chorionepithelioma with no foci in the genital tract.

Berman[20] in 1940 described a case of a woman aged 39 years, who gave a history of pregnancy 14 months before. Autopsy revealed chorionepitheliomatous masses in the liver, lungs, spleen, intestine, and brain.

The last reported case was by Maun and Green[21] in 1943, who recorded a case in a primigravida who was delivered normally of an infant on May 28th, 1942. The placenta was expelled spontaneously but was not submitted for laboratory investigation. Three months later she was admitted to hospital complaining of progressive weakness and chills of 2 weeks' duration. Except for anaemia, which was treated with iron therapy, nothing abnormal was detected and she was discharged in September 1942. Eleven days later she was again admitted with increasing weakness and she died on the 25th September 1942, i.e. 5 months after confinement. Postmortem revealed a large tumour in the liver which on microscopic examination showed a typical chorionepithelioma. The lungs were normal and no evidence of a genital neoplasm was discovered, although multiple sections of the uterus were investigated.

To the above 15 cases of extragenital chorionepithelioma I would like to add a sixteenth, the extreme rarity of which is sufficient to justify its publication, as not only are there no recorded cases of such a condition in the literature of this country, but also no reference to the extragenital type of growth is made in the British textbooks of Gynaecology.

Case History.

Mrs. L. B., a married woman, aged 27 years, was admitted to this hospital on June 10th, 1944, as an emergency, complaining of absence of foetal movements of 1 week's duration and a lump in her right breast which had first appeared 2 months previously.

The history obtained was that in 1940 she had had a normal delivery of a living child, and in March 1943, a 14 weeks abortion. Since then her periods had been regular and normal until early November 1943 when her last menstruation was stated to have occurred.

She had been attending an antenatal clinic and was well until 2 months before admission to hospital, when she first noticed a small lump in the right breast, which had gradually increased in size. She did not complain of any pain or tenderness in the swelling and no unusual discharge had been noticed from the nipple.

About 1 week before admission to hospital she detected the absence of foetal movements, which had been present every day since the 20th week of her pregnancy. At about the same time she complained of increasing listlessness and shortness of breath with the slightest exertion. She called in her doctor, who sent her to hospital.

Examination.

The patient had a sallow complexion and there was distinct pallor of the mucous membranes. Temperature, 98.6°F.; pulse-rate, 110; respiration-rate, 20; blood-pressure, 138/90; urine, clear; heart-rate 110 per minute, regular. Soft apical systolic murmur heard over the mitral area; lungs, clear.

Right breast. An obvious enlargement was noticeable, due to a lump in the median lower quadrant. No signs of inflammation were present. On palpation a non-tender, smooth, and freely mobile swelling, the size of a billiard ball, was felt in the median lower quadrant of the breast. There was no attachment to the skin, nipple, or deeper structures. No axillary glands were felt.

A provisional diagnosis of fibroadenoma was made. Surgical intervention was not deemed necessary until after termination of the pregnancy.

Abdomen. Height of the fundus uteri equivalent to a 32 weeks pregnancy. Vertex presentation palpated. Foetal heart sounds were not heard.

A diagnosis of intrauterine death was confirmed by X-ray examination.

June 13th, 1944. Blood examination: haemoglobin, 45 per cent; red-blood corpuscles, 2,400,000; colour index, 0.9.

Two pints of blood were administered.

June 14th, 1944. Medical induction. Benztrone 100,000 I.B.U. b.d. for 2 days followed by oil, enema, and pitocin. Unsuccessful.

June 17th, 1944. Similar induction to the above repeated with the same result.

June 18th, 1944. High puncture of the membranes performed, and 18 ounces of meconium-stained liquor drained off. Five hours later delivery of a macerated stillborn child occurred, followed soon afterwards by a very unhealthy-looking placenta which was not submitted for laboratory examination. Postpartum loss was normal. Following delivery, the general condition of the patient deteriorated, the pulse-rate varying between 120 and 140 with marked pallor. In spite of repeated blood transfusions (about 9 pints were administered over a period of 13 days) increasing cachexia occurred. Death took place on July 1st, that is, about 2 weeks after delivery.

Repeated blood cultures and a cervical smear were negative. Vaginal examination performed on June 23rd revealed slight tenderness in the left fornix. The only other feature of note, which occurred on June 21st, was a very profuse offensive non-blood-stained lochia.

Postmortem Findings.

Fairly well-nourished adult female.

Right breast. A swelling 4 inches by 2 inches by 1½ inches in size was excised from the substance of the right breast in the median and lower quadrant (Fig. 1). Sharply demarcated from the normal breast tissue, the lump was of a greyish mottled appearance with several haemorrhagic areas. Necrotic and friable in consistence.

Microscopic appearance. (Figs. 2, 3 and 4.) The tumour consists mainly of necrotic tissue with marked areas of haemorrhage. The central portion is made up of fibrin and red-blood cells. Trophoblastic cells are present around the periphery of the tumour showing marked pleomorphism. Langhans' and syncytial cells are present The area of necrosis is out of all proportion to the small number of malignant cells found.

The appearance of the tumour is that of a typical chorionepithelioma.

Uterus. Size 7½ inches by 5 inches by 4½ inches (Fig. 5). Placental site identified in the right anterior wall of the fundus. Evidence of any form of neoplasm was not discovered.

Microscopy. Sections cut from the wall of the uterus failed to show any abnormality.

Ovaries (Fig. 5). Both ovaries were enlarged, 3 inches by 2½ inches by 1½ inches, and cystic. On section multiple cysts were found, filled with amber coloured fluid.

Microscopic appearance. Multiple cysts of the paralutein variety present. Evidence of malignancy was not found.

Lungs (Fig. 6). Almost the entire surface of both lungs were studded by multiple purplish blue nodules, raised above the surface of the normal lung substance. The nodules, which varied in size from about ½ inch to 3 inches in diameter, are of

solid consistence. Cross section of the tumours disclosed necrotic friable masses of haemorrhagic tissue, well demarcated from the surrounding lung.

Microscopic appearance. The tumours consisted mainly of necrotic foci of tissue with well-marked areas of haemorrhage. Large numbers of syncytial and Langhans' cells were present.

Liver. As in the lungs this organ was enlarged and studded with multiple nodules varying in size from 1 inch to 1½ inches in diameter. The appearance is similar to the above organs microscopically.

Spleen, kidneys, and suprarenals showed similar appearance to the organs described above. The brain was not examined.

Conclusion. Extensive chorionepithelioma of the extragenital type.

Discussion.

Several aspects of the present case seem worthy of discussion and comparison with the cases recorded above.

Relation to Pregnancy.

In respect of its clinical relation to pregnancy, three types of chorionepithelioma may be distinguished (Teacher,[22]).

1. That in which the disease develops during pregnancy.

Many cases of genital chorionepithelioma falling into this group, have been reported. The commonest site described appears to have been the vagina. Out of the 16 cases of the extragenital variety reported above, the only case which appears to have developed during the course of pregnancy, is the one described in the present paper. The occurrence of a chorionepithelioma of the extragenital variety during pregnancy was emphasized by the appearance of a neoplastic focus in the right breast 11 weeks before death. One cannot of course exclude the 14 weeks abortion, which had occurred 8 months previously, as the original basis for the development of the growth, in which case one could include the case described as being both postpartum and intrapartum.

2. That in which the disease develops after a definite interval of several months to several years.

The vast majority of cases of both genital and extragenital variety fall into this group.

3. That in which the clinical relation to pregnancy is obscure.

In this group one can include the cases of so-called "teratomatous" origin (*vide infra*).

Nature of the Pregnancy Immediately Preceding the Occurrence of the Chorionepithelioma.

Teacher[22] in a series of 188 cases of all types reported the following:

	Cases	Per cent
1. After hydatidiform mole	73	36.6
2. After abortion	59	31
3. After labour at or about term	49	28
4. After extrauterine gestation	7	4.4

Dorland[23] in a series of 50 cases found the following:

	Cases	Per cent
1. After hydatidiform mole	20	40
2. After labour at or about term	17	34
3. After abortion	12	24
4. After tubal pregnancy ...	1	2

In the 16 cases of the extragenital variety reviewed above:

1. Five cases occurred after labour at or about term (31.25 per cent).
2. Four cases occurred after abortion (25 per cent).
3. Two cases occurred after hydatidiform mole (12.5 per cent).
4. Four cases gave no history of pregnancy (25 per cent).
5. One case occurred during the course of pregnancy (6.25 per cent).

Distribution of the Tumours.

In the 16 cases reported, the distribution was as follows:

Thirteen in the lungs, 10 in the liver, 8 in the kidneys, 7 in the intestines, 5 in the brain, 2 in the suprarenals, spleen and

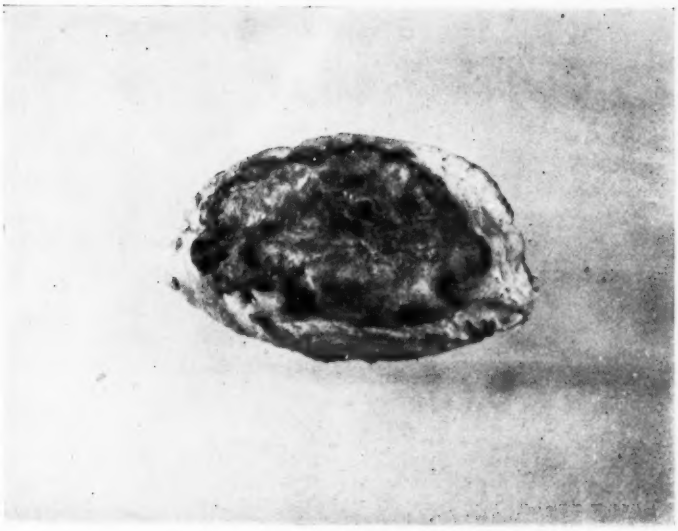

FIG. 1.

CHORIONEPITHELIOMA OF THE BREAST.

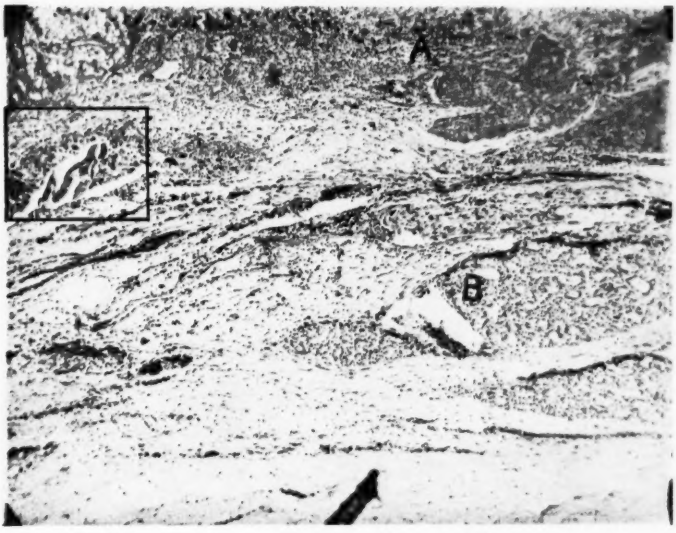

FIG. 2.

CHORIONEPITHELIOMA OF THE BREAST.

A. Area of haemorrhage and necrosis.
B. Normal breast tissue.
Squared area—Chorionepithelioma.

L.R. × 50

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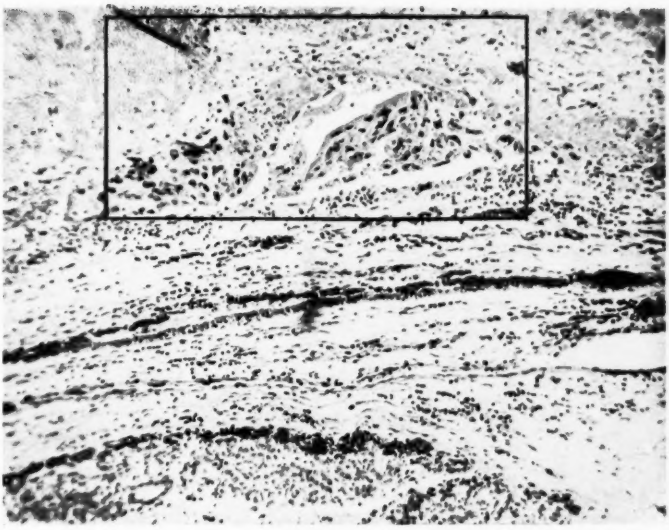

FIG. 3.
CHORIONEPITHELIOMA OF THE BREAST.
Squared area of Fig. 2 under high power. × 120

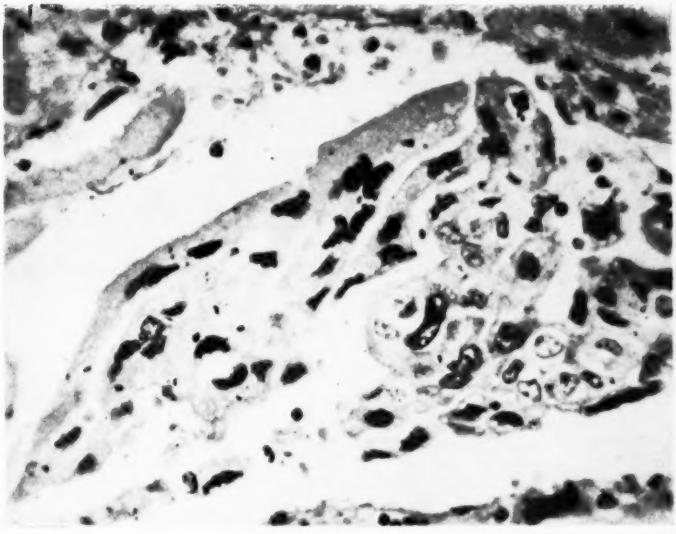

FIG. 4.
CHORIONEPITHELIOMA OF THE BREAST.
High-power view of squared area. Note syncytial and Langhans' cells.
L.R. × 450

UNIV. OF MICH.

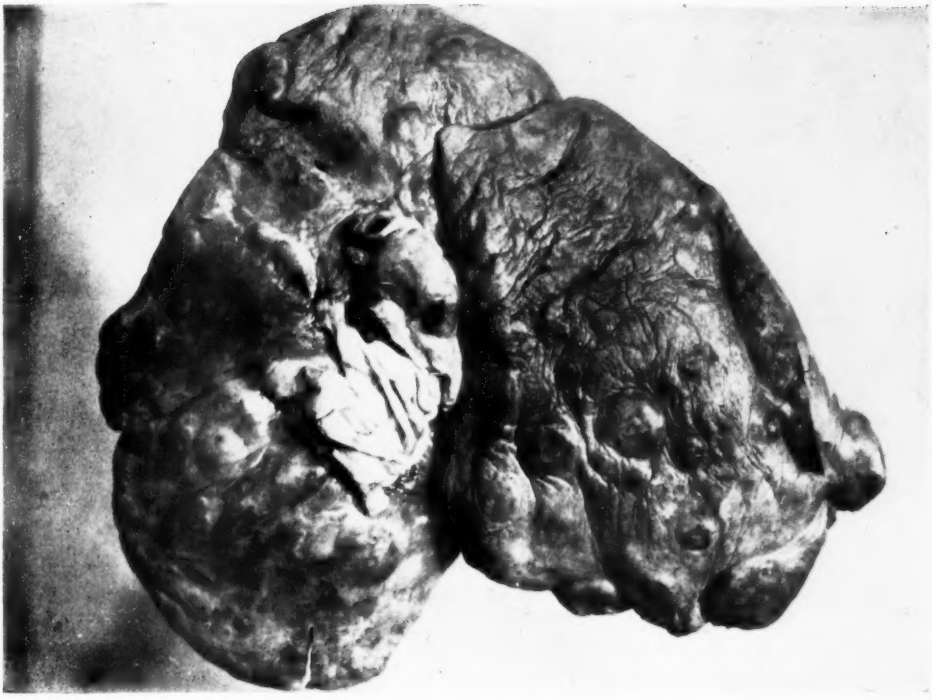

FIG. 6.

CHORIONEPITHELIOMA OF THE LUNGS.

L.R.

UNIV. OF MICH.

FIG. 5.

UTERUS AND OVARIES.

Placental site in anterior aspect of fundus. Note bilateral multiple theca lutein cysts of ovaries.

L.R.

UNIV. OF MICH.

thyroid, one each in the mediastinum, heart, pancreas, and breast.

It is noteworthy that out of the 16 cases, in 13 the tumours were found in the lungs, and in 10 in the liver, which seems to suggest that these two sites are the commonest for the development of extragenital chorionepithelioma. The occurence of chorionepithelioma in breast tissue in the case recorded in the present paper, is particularly interesting, as not only is this the first recorded case but also this feature was the deciding factor in concluding that the chorionepithelioma occurred during the course of the pregnancy.

Aetiology.

The occurrence of chorionepitheliomatous growths in extragenital organs without microscopic evidence of a primary focus in the genital tract, has led to the formulation of several theories regarding the origin of the tumours.

(1) *Transportation of chorionepitheliomatous emboli from a previous chorionepitheliomatous placenta completely expelled during labour.*

Schmorl[24] examined the lungs of 158 patients dying at different stages of pregnancy or after delivery and found chorionic cells in the lung capillaries in 80 per cent of the normal pregnancies. In the lungs of women dying of eclampsia, chorionic cells obstructed the capillaries, sometimes extensively, in every case examined. In 8 out of 22 cases dying of abortion, during the first 2 months, there were chorionic cells in the lung capillaries. In only 3 cases was there evidence in the lung capillaries of chorionic cell proliferation, and in view of the lack of examination of the placenta, hydatidiform or chorionepitheliomatous changes could not be excluded.

In accordance with these findings, Schmorl laid emphasis on the possibility that "ectopic" chorionepithelioma might originate from a previous mole, or chorionepitheliomatous proliferation of a placenta completely expelled during labour. He quoted a case in which 18 weeks after a normal pregnancy, a tumour was detected in the vagina. Death occurred within 6 months. The uterus and appendages were not involved by any growth, but metastases were found in the lungs, liver, kidney, and intestines. The vaginal neoplasm and the metastases gave the typical picture of a "syncytial" growth.

Schmorl believed that the process had originally started in the placenta which, however, had been expelled before the uterus was directly attacked, but not until metastases had commenced.

(2) *Malignant transformation of transported chorionic emboli from a normal placenta.*

Marchand[8] and Pick[26] maintained that chorionic cells or villi deposited during normal pregnancy may likewise give rise to chorionepithelioma, and that most cases of "ectopic" chorionepithelioma revealed a history of normal pregnancy, hydatidiform mole being relatively rare.

The opinions of Marchand and Pick received support from an observation made by Walthard[27]. He found a chorionepitheliomatous nodule in the vaginal wall of a patient during the 8th month of her 5th pregnancy. Caesarean section and total hysterectomy were performed and evidence of either a mole or neoplasm was not found in the uterus or placenta. Death occurred 7 months later, chorionepithelioma being found in the liver, lungs, and left kidney. The author considered the nodules to be metastases from a primary "ectopic" chorionepithelioma of the vagina, developed during the course of a normal pregnancy.

(3) *Complete regression of the uterine tumour with continued growth of the metastases in distant organs* (Novak[28]).

Cases of spontaneous cure or cure after incomplete operation have been described by several authors including Neuman,[29] Pick,[30] and Teacher.[22]

Novak[28] considers that approximately 10 per cent of cases undergo such a favourable course.

Kelly and Teacher[31] demonstrated histologically that some of the tumours in the parametrial veins had become extinct, the tumour cells being embedded in thrombus, the formation of which apparently destroyed them.

In 1907 Teacher was able to demonstrate healed nodules in a case of chorionepithelioma and to give some account of the healing process.

The view that the spontaneous cure resulted from shutting off of the blood supply of the tumour through choking of the blood vessels by trophoblastic tissue has been abandoned (Novak). The more probable explanation appears to lie in some unknown factor of general body resistance to the inroads of the disease.

The same explanation would seem to hold good for cases in which primary uterine tumours were found to be present, with distant metastases such as in the lung, and yet healing has occurred without radical operation (Pick,[30] Neuman[29]).

(4) *Chorionepithelioma developing from the trophoblast of an extragenital teratoma.*

This possible explanation was first recognized by Kanthack and Eden,[32] and demonstrated to the London Obstetrical Society in 1896 in connexion with the discussion on deciduoma malignum, when it was recognized that malignant tumours identical with chorionepithelioma have been observed apart from pregnancy, and even in men.

Schlagenhaufer[33] advanced the view that the primary growth was a mixed tumour or teratoma, and that the chorionepithelioma-like tissues represented the chorionic epithelium. Many of these cases are described for the most part in connexion with the testes.

Lubarsch[34] described a chorionepithelioma occurring in a girl 13 years of age, who had never menstruated. In this case the tumour was found to be attached to the uterus.

Ritchie,[35] in 1903, found a chorionepithelioma which had occurred in a dermoid of the mediastinum of a man, and which had given rise to extensive metastases.

Emrys-Roberts and Walker Hall[36] in 1910, found a tumour in the retroperitoneal space between the kidneys of a man. Section of the growth disclosed a typical chorionepithelioma.

Suggested Cause for the Extragenital Tumours in the Present Case.

In relation to the present case, an explanation for the aetiology can be sought for in the theories outlined.

Bearing in mind that trophoblast is a normally invasive tissue and that masses of normal trophoblastic tissue and even clumps of chorionic villi may be deposited in distant fields, particularly the lungs, one cannot exclude the possibility of a chorionepitheliomatous transformation of such tissue in the lungs and the consequent extensive spread.

Considering Schmorl's[24] view, that is, transportation of chorionepitheliomatous emboli from a prior chorionepitheliomatous placenta, completely expelled during labour, it is not unlikely that such a course of events may have occurred, resulting in

the deposit of malignant foci in the lungs, primarily, as this organ is most commonly affected. Hence the explanation for the extensive secondary spread including the breast.

One could regard the theory of complete regression of a primary tumour in the uterus as unlikely in the present case, in view of the short period elapsing between expulsion of the placenta and the death of the patient, i.e., 13 days.

The theory of a teratomatous basis for the development of the chorionepithelioma is also unlikely in this case, in the presence of a 32 weeks pregnancy.

One might therefore conclude that in the present case the explanation for the development of the extragenital chorionepithelioma is a matter for conjecture. The cause can be sought for in the first two theories outlined. The chance that chorionepitheliomatous elements were present in the uterus, but in such minute quantities that they were overlooked, even after a most careful investigation of the entire genital tract, is also within the realms of possibility.

SUMMARY.

(1) Chorionepithelioma has been classified into two main groups:—

(a) *Genital group*, further subdivided into (i) *Uterine*, and (ii) *Extrauterine varieties*, i.e., primary vaginal, ovarian, and Fallopian tubes.

(b) *Extragenital group*, defined as chorionepithelioma manifesting itself in organs of the body remote from, and without any microscopic evidence of a similar growth in, the genital tract.

This group is dealt with mainly in this paper.

(2) The literature of 15 reported cases of extragenital chorionepithelioma is reviewed.

(3) The description of another case is given.

The case recorded is of particular interest, in that such a recorded case of extragenital chorionepithelioma has never appeared in the literature of this country, and manifesting a breast chorionepithelioma.

(4) A short discussion of its relation to pregnancy, the nature of the pregnancy immediately preceding the occurrence of chorionepithelioma and the distribution of the tumours is outlined.

(5) The aetiology of extragenital chorionepithelioma is briefly outlined, and an explanation for the origin of the growths occurring in the present case is offered.

My thanks are due to Mr. George Brown, Medical Superintendent to this hospital, for his permission to publish this case, and to Professor Daniel Dougal for his kind advice and criticism. For the clinical photographs I am indebted to Sister Winters.

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A Case of Coexisting Tuberculosis and Cancer of the Uterus

BY

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THE simultaneous occurrence of tuberculosis and cancer has been reported as being infrequent. The first observation is credited to Rokitansky,[1] who stated that the two processes occur together rarely, and that this is even more true of the two processes in the same organ. This statement has been repeatedly substantiated by others, including McCaskey[2] and White.[3] Nevertheless observations have been made and recorded concerning the occurrence in the same organ, but much more rarely than in the same organism. Until 1908 only 9 cases of carcinoma of the uterus with coexisting tuberculosis had been reported (Veit[4]), and they mostly showed squamous epithelioma of the cervix with tuberculous endometritis, or peritoneal tuberculosis as distinct from uterine disease. Comprehensive reviews by Wallart[5] and von Franqué[6] are the more exhaustive of the older literature.

Gais[7] reviews 27 cases of simultaneously occurring carcinoma and tuberculosis of the uterus and adds the description of his own case.

The earlier cases were thought to show that tuberculous endometritis was an aetiological factor in the production of the neoplasm, and that the malignant change occurred in the already diseased tissue as a result of chronic irritation, but most writers to-day rather believe that carcinoma and tuberculosis together are merely coincidental and have no bearing on one another except that carcinoma may predispose to secondary tuberculous involvement of the organ when a primary focus is present elsewhere in the body.[7] More recently cases have been reported by Petridis,[8] Novak and Windholz,[9] Ravid and Scharfman.[10] In view of the rarity of the association the following case is reported.

CASE HISTORY.

Mrs. R. R., aged 44, was admitted to a surgical ward in November 1943 complaining of pain in the right side. A diagnosis of acute appendicitis was made, the abdomen was opened, and a chronically inflamed appendix removed. During the operation it was found that the uterus was enlarged and both ovaries were small and atrophic. Evidence of tuberculosis was not then found. Progress was uneventful and the patient was later referred to the gynaecological department on November 24th, 1943. The gynaecological report stated "Uterus anterior, soft, globular and about the size of a grape fruit; ovaries not palpable." The patient had a history of a yellow vaginal discharge from January 1943 to August 1943, but this was relieved by pessaries given by her own doctor. The nature of the pessaries is not known. In December 1943 she was admitted for investigation. On December 1st, 1943, she experienced a sudden gush of thick yellow discharge from the vagina, followed by blood-stained fluid, preceded by, and followed by, severe abdominal pain. Examination revealed extreme tenderness

above the pubic symphysis and a mass was palpable through the anterior fornix.

Examination under anaesthetic.

The uterus was now retroverted and slightly enlarged anteriorly, but smaller than on November 24th, 1943. Curettings were not obtainable and uterine discharge was not present. Further treatment was not considered necessary. On March 30th, 1944, the patient was readmitted. She had been bleeding *per vaginam* for the previous 3 weeks and abdominal pain had become more severe. She now complained of frequency of micturition, and blood now came in large clots.

Vaginal examination.

The uterus was enlarged, retroverted, and a mass was palpable in the anterior fornix.

On April 7th, 1944, a subtotal hysterectomy was performed, with removal of the right adnexa. White nodules were present at the uterine end of both Fallopian tubes, and the ovaries appeared healthy. On opening the uterus a growth was seen in the posterior uterine wall, protruding into the cavity. The diagnosis of carcinoma of the body of the uterus was made, with metastatic deposits in both Fallopian tubes.

Macroscopic examination.

The uterus, which had been removed supravaginally, measured 10 by 8 by 5 cm. The right Fallopian tube and ovary were attached, and adjacent to the proximal end of the tube there was a soft whitish nodule, 1 cm. in diameter, with the appearance of tumour tissue. The right ovary was small, scarred and firm, measuring 2 by 1 by 0.5 cm. It presented no obvious gross abnormalities.

Arising from a broad base in the fundus of the uterus was a bulky, papillary, friable mass, whitish-grey in colour, projecting into, and almost completely filling the uterine cavity. The base of the tumour was not well defined. Areas of necrosis were numerous, but caseation was not observed. Below the main tumour mass two small whitish circular nodules, 1 cm. and 1.2 cm. in diameter respectively, were present on the posterior wall, the first 1.5 cm. and the second 3.5 cm. below the main growth. These areas were slightly raised and appeared to be metastatic neoplastic processes, as if produced by lymphatic permeation. The myometrium was thickened and fibrosed, with prominent vessels visible, and measured 2.25 cm. in thickness. Definite tumour tissue or nodules were not seen in the interstitial tissue. The external surface of the uterus appeared normal. The left ovary and Fallopian tube were unattached.

Microscopic examination.

Representative blocks, fixed in saturated mercuric chloride with 10 per cent formalin and embedded in paraffin, were examined. The structure of the tumour mass was that of a cellular anaplastic growth in which were a few cystic spaces containing pinkish hyaline material. The cells were mainly large and clear with large vesicular nuclei, many being vacuolated, and arranged in alveoli; mitotic figures were numerous. The stroma was thin and scanty, showing polymorphonuclear infiltration as well as some large mononuclear cells containing coarse brown pigment granules. The surface showed ulceration and necrosis with a layer of polymorphs and fibrin superimposed. Considerable areas of necrosis with hyalinization of the stroma and polymorphonuclear infiltration were present. An occasional gland-like space containing polymorphs and *débris* could be seen. Some areas of epithelium showed squamous metaplasia. Near the margin of the tumour, tubercle follicles

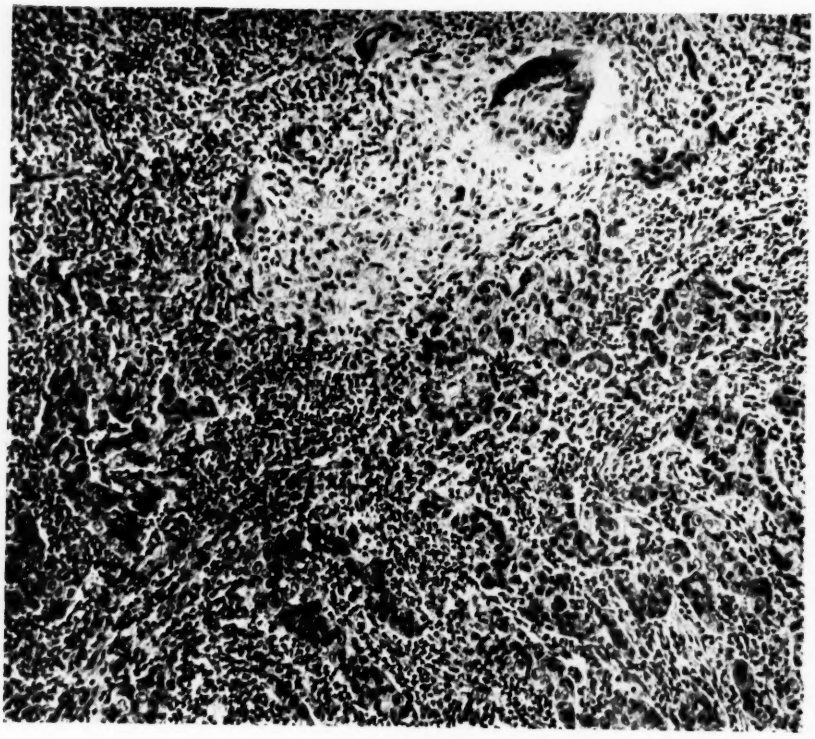

FIG. 1.

Section from small nodule 1.5 cm. below main growth. Note one tubercle follicle with giant cell, separated from tumour cells by zone of lymphocytes and fine connective tissue. × 90 diameters. Stained Celestine Blue and Chromotrope.

G.H.S.

UNIV. OF MICH.

were present. These follicles did not show caseation, but consisted of central areas of necrosis surrounded by proliferating endotheloid cells with a peripheral lymphocytic mantle and centrally placed giant cells. The endometrium beyond the tumour margin was thin, with scanty glands, the epithelium of which, however, was fairly high. The stroma of the endometrium was the seat of marked chronic inflammatory change but tubercle follicles were not present. Sections taken from the small nodules described above showed the same structure as the main tumour with the addition of tubercle follicles within the neoplastic process, near the surface. The follicles, mostly with giant cells, were separated from the tumour cells by a zone of lymphocytes and a layer of fine connective tissue. The endometrium beyond those nodules showed chronic inflammatory change with tubercle formation and small areas of caseous necrosis. In those sections the myometrium showed superficial penetration by numerous epithelial masses, while a few lymphatic channels contained groups of tumour cells at some distance from the tumour mass. Other lymphatics frequently had aggregates of lymphocytes around them.

Transverse sections through the portion of the Fallopian tube first thought to be the site of metastasis revealed the nodule to be entirely made up of caseating tuberculous salpingitis with well-formed giant-cell systems. Tumour cells were not seen and evidence of peritoneal involvement was not present.

Sections of the right ovary showed hyalinization of the walls of vessels and endarteritis. Corpora albicantia and areas of fibrosis were numerous.

Attempts to demonstrate tubercle bacilli in the lesions by the Ziehl-Neelson method were unsuccessful.

Discussion.

The study of the tumour leads to the conclusion that it was an anaplastic adenocarcinoma of the body of the uterus. The tubercles were largely non-caseous and evidently fairly young. Their distribution and development would suggest that they are younger than the tumour and probably disseminated from the obviously older tubal lesion. It is interesting to find tubercle follicles in the tumour mass itself and in continuity with the neoplastic process. There is nothing to suggest that the tuberculous process has any bearing on the origin of the tumour. The cervix was not removed and unfortunately could not be examined. It appears, therefore, that the tuberculous involvement was secondary and probably by lymphatic or haematogenous spread from a distant focus, presumably the older tubal lesion. The association seems to be accidental, except that the uterine tumour may have acted as a favourable nidus for the development of the tuberculous lesion spreading from the Fallopian tubes.

The patient was investigated for further evidence of tuberculosis but neither pulmonary or renal lesions could be detected and she left the hospital in good condition. To date no further trouble has been reported.

Summary.

A case of coexisting carcinoma and tuberculosis of the uterus is described, the former process apparently being the older one, the tuberculous lesion having probably been secondary to the tuberculous salpingitis.

I have to thank Dr. Jean Herring for permission to publish the clinical notes, and I am indebted to Professor D. F. Cappell for much helpful criticism and advice.

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Dysgerminoma of the Ovary in a Child of Five Years with Acute Torsion of the Pedicle

BY

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THIS case is reported on account of the comparative rarity of the tumour, the unusual clinical history, and because the girl in which it occurred was only 5 years of age, which is the youngest age I can find in the literature available.

In Novak and Gray's[1] paper on this type of tumour a total of 17 cases were reported, the youngest being 6 years of age. In one of these cases there was torsion of the pedicle.

The patient was a girl 5 years of age. On June 18th, 1943, she had a sudden attack of abdominal pain and 24 hours later was seen by a surgeon. She was vomiting, and was tender and rigid over the right iliac fossa. A large mass was also felt in this region on palpation and a diagnosis was made of a possible appendicular abscess and a laparotomy was performed. A tumour of the right ovary, which had twisted twice on its pedicle, was found and removed. No other abnormality was present, there were no abnormal sexual changes and the patient made an uneventful recovery.

Pathological report: "This tumour is the size and shape of a cricket ball and has a smooth, dense and intact capsule. On cutting it is white and brain-like in appearance and firm with a rubbery consistence. Cystic changes are not seen but oedema and congestion are present. The microscopic details are not all one would wish but this is due to the blood supply of the tumour having been obstructed for over 24 hours before removal. The main type of cell is large and round with abundant clear cytoplasm and a relatively large round or oval nucleus with a well-marked nuclear membrane and sometimes showing nucleoli. Occasional mitotic figures are seen. The cells are arranged in alveolar formations and in columns by fibrous septa which show hyalinization and contain many small lymphocytes and histiocytes. Two large symplasmic giant cells were found after an extensive search. This tumour has the typical appearance of a dysgerminoma. The prognosis is good on account of the age and sex of the patient, the type and appearance of the cells and the scarcity of mitotic figures, and because the tumour was unilateral and was removed with an intact capsule which shows no evidence of infiltration."

This type of tumour was first satisfactorily classified by Meyer[2] in 1931. It develops from the asexual or neuter cells of the foetal parenchyma and in the male is called a seminoma. It is often accompanied by pseudohermaphroditism or subnormal gonadal development which is not due to the influence of the tumour cells but is concomitant with the tumour. The presence of large giant cells with so-called epitheloid cells is usually characteristic and has deceived pathologists into thinking it tuberculous, and cases have been reported as "sarcoma with tuberculosis." These giant cells were not a feature in the present case. Due to the small number of reported cases

the malignancy of the tumour is not known with a great degree of accuracy but Schiller suggests it as 10 per cent in females, 90 per cent in males (i.e. seminoma) and 50 per cent in hermaphrodites.

SUMMARY.

A case of dysgerminoma of the right ovary with acute torsion of the pedicle occurring in a girl aged 5 years and successfully removed at operation is reported.

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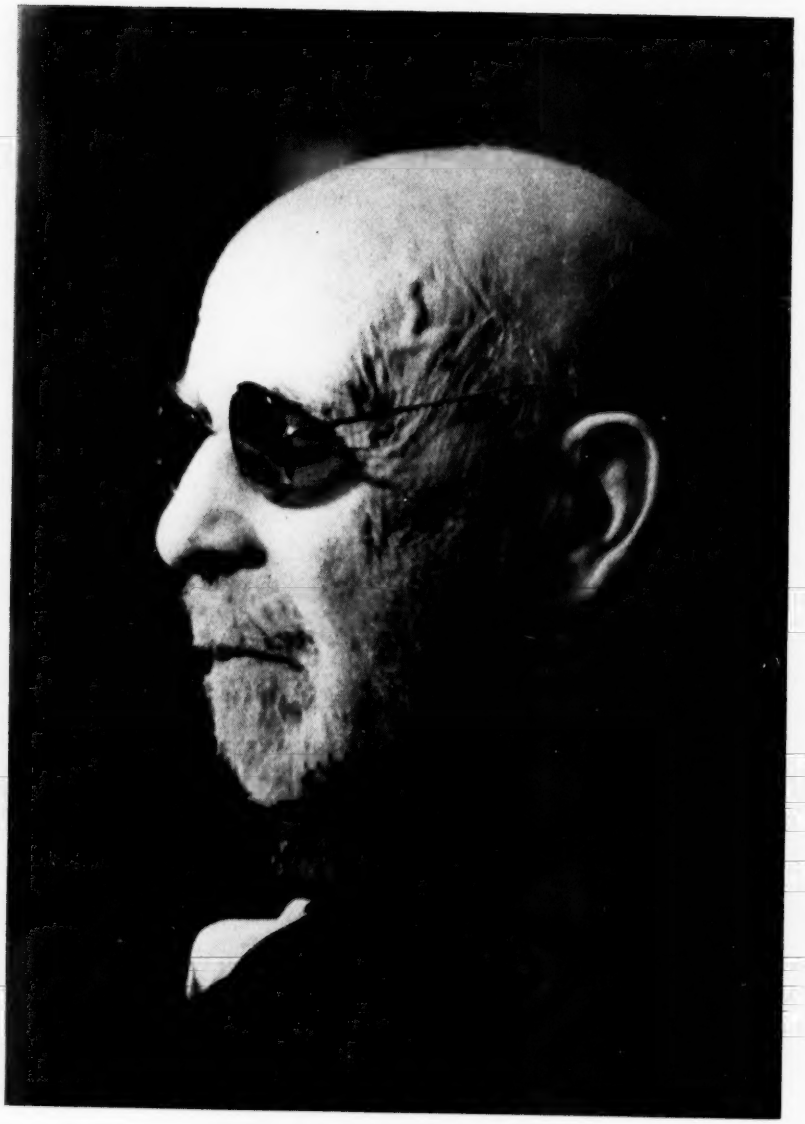

ERNEST HASTINGS TWEEDY

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Obituary

Ernest Hastings Tweedy

1862—1945

By the death of Ernest Hastings Tweedy of Dublin, not Eire only but Great Britain and the Dominions have lost one of the outstanding figures in obstetrics and gynaecology of the present century. It cannot be expected that a man who defeated death for 83 years can have many obstetric contemporaries left to wave him farewell, as Charon guides his faltering steps aboard, and ferries him over to the Elysian fields. Indeed, I can call to mind only Comyns Berkeley, Eden, Miles Phillips and myself. Our presence on the river's bank, could it have occurred, would certainly have heartened him greatly; and even more an assemblage of the great company of students who came under the influence of this master in obstetrics, could his passing have been staged as here suggested.

From this, the young generation, who never had the privilege of meeting him, will judge that Hastings Tweedy was a great fellow. The positions he occupied, and more especially the honours conferred on him by learned bodies, bear testimony to the high regard in which he was held by his contemporaries. The list is an impressive one—M.D. Hon. Causâ, Trinity College, Dublin; Hon. Fellow of the Royal Academy of Medicine in Ireland; Hon. Fellow of The Royal College of Obstetricians and Gynaecologists; Master of the Rotunda Hospital (1903–1910); Gynaecologist to Dr. Steevens Hospital, Dublin; President of the Obstetrical and Gynaecological Section of the British Medical Association (Annual Meeting in Exeter).

These and other lesser honours are but the trappings; it is the personality of the man that his old friends especially desire to recall and to honour—in the words of Robert Burns "the man's the gowd for a' that." And his personality shone out in all he said, wrote, and did. I remember being struck by it at a little luncheon party following a session of the Congress which the late Louis Cassidy, Master of the Coombe, had organized in 1926 to celebrate the centenary of another of Dublin's great maternity hospitals. After lunch we split up into little groups. First one and then another moved over to the group at which Tweedy was holding forth as was his wont. Very soon all were around him entertained by his sallies and reminiscences, thrown off with the same informality of language and expression as when I first met him in 1892.

He joined up at the Rotunda the day before I did—so we began the serious study of obstetrics and gynaecology together. In my mind's eye I can see him as when we first met—his stocky figure in front of the mess room fire declaiming on something or someone with that exaggeration of phraseology typical of Irish humour which was never really understood or appreciated by his colleagues in London.

As can readily be realized these characteristics, coupled with his wide knowledge

of practical obstetrics and gynaecology, made him an outstanding clinical teacher. His ward visit was the event of the day and his remarks round the bedside were often recalled when in after years his old pupils foregathered.

Tweedy's most important literary work on Obstetrics was *Practical Obstetrics*, which appeared first in 1908. Wrench was his collaborator, as he was in the succeeding three editions. In the fifth edition Bethel Solomons took over from Wrench, while the last edition, the seventh, published in 1937, bears on the title page "*Tweedy's Practical Obstetrics*. Revised and largely rewritten by Bethel Solomons and Ninian Falkiner." So right down until just before the war his memory was kept fresh by former pupils and personal friends. The contributions he made to the medical journals of his time always aroused interest, and generally controversy—one recalls papers on eclampsia and its treatment with morphia; on accidental haemorrhage and his advocacy of the tampon; on obstetric shock; and one on resection of the Fallopian tubes in which he advocated the employment of strands of catgut introduced into the resected tube to maintain its patency.

Tweedy, like Smyly (whose pupil and assistant he was), was a great "Master"—incidentally they were first cousins. During the reigns of both, many additions were made and improvements introduced in the Rotunda which for well nigh two hundred years has stood out as an example of how an obstetrical and gynaecological hospital should be staffed—a Master and two Assistant Masters resident in the hospital ready to advise or to deal with any obstetrical complication. Little wonder that year after year the maternal and foetal mortality and morbidity rates were outstandingly low. I received the other day a note from O'Donel Browne, Tweedy's son-in-law, in which there is this statement: "His seven years' mastership in the Rotunda yielded the lowest maternal mortality rate *to date*, despite the use of chemotherapy since 1936."

Tweedy took delight in his work both private and hospital. Naturally, therefore, he was beloved by all—patients, students and nurses. Then in 1922, when at his zenith, the tragedy occurred—he became totally blind and his professional life came abruptly to an end.

As might be expected the reaction to this disaster was characteristic of him—he simply added fortitude to his other great qualities. And in no small measure was he sustained in this fortitude by his beloved wife and devoted family, Major Ernest S. Tweedy, R.A.M.C., and Mrs. O'Donel Browne, to whom all we who knew him tender our deepest sympathy.

On the note of loyalty to his friends I close this very inadequate appreciation of a great spirit. Many years ago we foregathered in the hall of the Euston Hotel—I had arrived off the night train from Glasgow—Tweedy was on the point of leaving for Dublin by the day train *via* Holyhead. Without much persuasion he wired the Rotunda and postponed his departure until the following morning. We had a wonderful day together; but I can recall clearly only the finish of it. We had booked seats for some play and decided to dine at "Scotts." Looking at our watches half-way through dinner, we discovered that the play had long since started. Without more ado we tore up our tickets and ordered another bottle.

J.M.M.K.

ROYAL COLLEGE OF OBSTETRICIANS AND GYNAECOLOGISTS

THE Quarterly Meeting of the Council was held in the College House on Saturday, January 27th, 1945, with the President, Mr. Eardly Holland, in the Chair.

The following candidates were elected to the Membership of the College:

Amelia Esther Burch.
James Paton Orr Erskine.
Eric Garland-Collins.
Andrew Bertram Hay.
Jadwiga Karnicki.
Gladys Elizabeth Keith.
Dorothea Mary Kerslake.
Dorothy Margaret Shotton.
Benjamin Gibson Gunlys Spiers.
Dorothy Joan Thompson.

BOOK REVIEW

" Textbook of Gynaecology." By WILFRED SHAW, M.A., M.D., F.R.C.S., F.R.C.O.G. 4th Edition. J. & A. Churchill. 24s.

IN spite of war-time difficulties there have been three editions of this book since its original publication in 1936, and both second and third editions have been reprinted. As it has thus become, in a relatively short time, one of the favourite standard works on the subject with the present-day undergraduate student, the question arises as to whether this popularity is deserved. On the whole, the book can be recommended with confidence. The material, which is logically and attractively presented, is detailed enough both to fulfil the requirements of the final examination, and, after qualification, to act as a guide to the management of gynaecological cases in general practice.

The chapters on anatomy and physiology are particularly good, and, as would be expected from such a master of the subject, the pathological descriptions are excellently written and well illustrated. Practising gynaecologists, however, find it difficult to believe that, if as stated, 15 per cent of women over the age of 35 have myomata, histology shows sarcoma in 1.5 per cent of the specimens examined.

The present edition includes new work on chemotherapy and endocrinology. Compared with the rest of the book, these sections are disappointing. Chemotherapy is discussed in dealing with gonococcal lesions, other types of acute salpingitis and urinary infections. Only sulphapyridine and sulphanilamide are mentioned and, in the chapter on gonorrhoea, it would appear that these drugs are made up in one gramme tablets. As chemotherapy is so effective in combating this infection, it would seem unnecessary to advise vaginal douching at least four times a day for chronic gonorrhoeal cervicitis.

Shaw rightly advocates care in selecting cases suitable for endocrine treatment, but he does not sufficiently stress the dangers of overdosage. Stilboestrol, being cheap to buy and easy to take, is much too readily prescribed by some general practitioners as a panacea for every gynaecological disturbance. They may be further encouraged when they find that the author would give up 15 mg. a day in some cases of amenorrhoea, 30 mg. a day for kraurosis vulvae, and 5 mg. a day, in addition to oestrin pessaries, for Trichomonad infections, particularly as he does not say how long treatment should be continued. No mention, however, is made of the use of oestrogens in the treatment of missed abortion. In contrast, the injection of 36 I.U. daily of serum gonadotropin that he recommends to promote ovulation would seem insufficient, and must be difficult to administer when the appendix at the end of the book shows that the hormone is prepared in ampoules of 100–1,000 I.U. per c.cm. This appendix, which lists the proprietary preparations along with names of the active principles they contain, is very helpful in clarifying the confusion of nomenclature made by the commercial firms.

Additions have been made to the chapter on diseases of the ovary, which has always been one of the best in the book. It is a pity no mention is made of the much-discussed Meig's syndrome, for it would be interesting to know the author's views on the subject.

Though this book can, with a little qualification, be recommended to undergraduates and practitioners, it is hardly comprehensive enough for candidates taking the higher examinations. They are not well catered for in English literature, and until a larger up-to-date textbook is available, a bibliography added to Shaw's present volume might be of help to them.

INDEX TO CURRENT LITERATURE

In this Index an endeavour will be made, so far as war conditions permit, to maintain an up-to-date record of all titles bearing on obstetrics and gynaecology and the infant. The classification aims at making immediately available for the reader the titles under the various subject headings. In the majority of instances the title is obtained from the original publication. Where this has been impossible, the title has been obtained from the abstracting journal shown in brackets. Reprints will be welcomed and should be sent to the Editor.

Any inquiries should be addressed to Miss D. F. Atkins, British Postgraduate Medical School, Ducane Road, London, W.12.

	REF.
ANATOMY	1
PHYSIOLOGY	4
Menstruation	16
PREGNANCY	
Normal	18
Physiology	19
Diagnosis	23
Antenatal examination	30
Nutrition	33
Abnormal	
Toxaemias	36
Placenta praevia, accidental haemorrhage	43
Abortion	48
Association with disturbances of other maternal systems	50
Association with infections	64
Association with disturbances of the reproductive system	71
Ectopic pregnancy	75
LABOUR	
Normal	82
Abnormal	85
Anaesthetics, analgesics	98
Multiple births	104
PUERPERIUM	
General	106
Lactation	111
THE INFANT	
General	117
Congenital defects	126
Infections	150
Blood	163
Nutrition	177
Welfare, clinics	187
Mortality	190

REF.

MATERNAL WELFARE 194

MATERNAL MORTALITY 197

OBSTETRIC OPERATIONS 198

MISCELLANEOUS 204

GYNAECOLOGY
- General 206
- Disorders of function
  - Menstrual disorders 208
  - Anomalous uterine haemorrhage 210
  - Sterility 213
- Abnormalities of the reproductive organs 217
- Infections of the reproductive organs 221
- New growths of the reproductive organs 225
- Operations 243
- Miscellaneous 253

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